이학박사학위논문

Phylogeny and Systematics of the *Bistorta manshuriensis* Complex (Polygonaceae)

Bistorta manshuriensis Complex (마디풀과)의 계통과 분류

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GAURI SHANKAR BHANDARI

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지도교수 박 종 욱

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Gauri Shankar Bhandari

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Abstract

Phylogeny and Systematics of the *Bistorta manshuriensis* complex (Polygonaceae)

Gauri Shankar Bhandari
School of Biological Sciences
College of Natural Sciences
Seoul National University

The *Bistorta manshuriensis* species complex consists of five closely related and morphologically variable taxa distributed in northeast Asia including Russian Far East, northeast China, Korea and Japan. Taxonomic identity and species delimitations have been problematic in the complex. To delimit species boundaries, and to clarify taxonomic postion and phylogenetic relationships within the *B. manshuriensis* complex, major morphological characters were examined and DNA sequences were analyzed. The results of morphological analyses show that the length and width of leaf blade, position of maximum width in the leaf blade ratio between length and width of leaf blade, length of petiole wing are useful characteristics in distinguishing the taxa of the complex. Study of leaf epidermal surface using Scanning Electron Microscope showed that epicuticular wax and stomatal density was variable among the taxa. Somatic chromosome counts revealed diploids (2*n* = 24) and tetraploids (2*n* = 48) in the complex. The chromosome counts reported herein represented the first reports for *B. manshuriensis* and *B. alopecuroides*. Variations in ITS and cpDNA regions were examined in 182 accessions sampled from 82 populations from almost the entire distribution area of the taxa of the *B. manshuriensis* complex. Twenty eight ribotypes were identified on the basis of 22 substitutions and one indel in the ITS. Ribotype polymorphism was prevalent in all taxa of the complex and in majority of the populations. A geographically widespread ribotype, distributed in all populations except two populations in Korea, was detected. Among 28 ribotypes identified in the complex, eight were shared by two or more taxa and 13 ribotypes were population-specific. Forty three haplotypes were identified on the bases of 64 nucleotide substitutions and one indel in the combined cpDNA sequence data. Eight haplotypes were shared by two or more taxa of the complex, and 27 haplotypes were population-specific. A geographically widespread haplotype distributed in 34 populations was detected in the complex. TCS haplotype network and phylogenetic tree analyses inferred from the combined cpDNA sequence data indicated several lineages in the complex. However, no lineage corresponded to the currently recognized delimitations of taxa suggesting that the speciation in the *B. manshuriensis* complex involved a complex pattern of hybridization, incomplete lineage sorting, mutations and geographical divergence. Based on morphological, cytological and molecular results, three species and two subspecies were recognized in the *B. manshuriensis* complex in northeast Asia and the description of all taxa and keys to the taxa are provided.

***Keywords* - *Bistorta manshuriensis*, cpDNA, haplotype, ITS, northeast Asia**

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I. Introduction

The genus *Bistorta* [(L.) Scop.] (Polygonaceae) comprises 30 to 50 species (Yonekura and Ohashi, 2001; Li et al. 2003; Freeman and Hinds, 2005; Galasso et al., 2009) distributed primarily in the temperate and alpine regions of the Northern Hemisphere including Asia, Europe and North America. The primary center of diversity of *Bistorta* is in the Himalaya and adjacent regions, which contain about two-thirds of the species (Yonekura and Ohashi, 2001). The genus comprises about 15 taxa in northeast Asia. Among them, nine species are in the Russian Far East (Tzvelev, 1989), seven species are in northeast China (Li et al., 2003) and six species are in Japan (Yonekura, 2006). On the Korean peninsula, nine species of *Bistorta* have been reported, with one species described as being endemic (Nakai, 1938; Park, 1974; Lee, 1980; Lee, 1996; Park and Hong, 2007).

The diagnostic features of *Bistorta* include perennial habit, stout and often contorted rhizome, simple stem, basal rosettes, revolute leaf margin with broad nerves on the edges, cylindrical and oblique ochreae, spike-like cyme with dense flowers, five-parted perianth, eight stamens, fusion of nectaries with the base of the inner stamens to form a disc, and tricolpate pollens (Greene, 1904; Gross 1913b; Hedberg, 1946; Haraldson, 1978; Ronse Decrane and Akeroyd, 1988). Phylogenetic analyses of DNA sequence data strongly support *Bistorta* as being monophyletic (Kim and Donoghue, 2008; Sanchez et al., 2011).

Among the species of *Bistorta*, *B. officinalis* Delarbre is cultivated in Europe for ornamental purposes due to its beautiful flowers (Cullen et al., 2011).

The dried roots of *B. officinalis* have been widely used as Chinese folk medicine for the treatment of suppurative dermatitis, hemorrhoids, and hematemesis (PPRC, 2000). In Korea, the roots and rhizome of *B. manshuriensis* Kom. have been used as a medicinal herb to cure fever and diarrhea (Lim, 1961; NPRI, 1998). The species of *Bistorta* contain a variety of medicinally important flavonoids such as rutin, quercetin, myricetin, and kaempferol (Chang et al. 2009; Vysochina and Voronkova, 2013) indicating their potential commercial value as natural product resources for drug development.

The taxonomy of *Bistorta* is largely based on a combination of several morphological features such as habit, shape and size of rhizome, shape and size of the basal (radical) leaves, length of petiole, presence or absence of petiole wing, leaf pubescence, attachment of cauline leaves, bract shape, and shape and color of the perianth (Meisner, 1856; Petrov, 1928; Komarov, 1926, 1936; Nakai, 1938; Li et al., 2003; Yonekura, 2006; Park and Hong, 2007). *Bistorta*, however, is a taxonomically difficult group presenting confusion over the identity and circumscription of species, and the relationships among the species. In particular, *Bistorta* has: 1) few useful morphological characteristics to reflect affinity among the species, 2) complex pattern of variation due to overlapping distinguishing characters between populations, 3) geographically specific characters, 4) differences in the selection of characters and interpretations depending on the opinion of the author, and 5) lack of molecular phylogenetic studies to address phylogenetic relationships within *Bistorta*.

One prominent species complex within *Bistorta*, the *B. manshuriensis* complex includes closely related and controversial taxa distributed predominantly in northeast Asia. These include *B. manshuriensis* (Petrov ex Kom.) Kom. ex Nakai, *B. pacifica* (Petrov ex Kom.) Kom. ex Nakai and *B. alopecuroides* (Turcz. ex Besser) Kom. and two taxa from Japan supposed to be closely related; *B. major* Gray var. *japonica* H. Hara and *B. major* Gray var. *ovata* (Nakai ex H. Hara) H. Hara. The complex was previously circumscribed in series *Bistorta* (Komarov, 1936) or section *Bistorta* (Petrov, 1928; Tzvelev, 1987; Yonekura, 2006).

Bistorta manshuriensis was described by Komarov (1926) as *Polygonum manshuriense* Petrov ex. Kom. based on specimens collected in northern China (Manchuria) and the Khabarovsk region of the Russian Far East. It has been distinguished from closely related species by the presence of lanceolate or oblong basal leaves, cuneate leaf base and the presence of wings on the upper part of the petiole (Komarov, 1926, 1936). *Bistorta manshuriensis* is distributed in northeast China, Russian Far East and on the Korean peninsula (Komarov, 1926, 1936; Nakai, 1938: Li et al., 2003). Some Korean taxonomists, however, have not recognized this species as part of the Korean flora. Its distribution in Korea was first reported by Nakai (1938), who was followed by subsequent authors (Park, 1974; Lee, 1980, Park and Hong, 2007). However, Chung (1957) did not recognize *B. manshuriensis* as being in Korea. He was followed by Lee (1996), who recognized *B. major* var. *japonica* (≡ *B. officinalis* subsp. *japonica*), originally described from Japan, in Korea, and excluded *B. manshuriensis* from the Korean flora. In contrast, Lee (1996) considered both *B. manshuriensis* and *B. major* var. *japonica* to be in Korea.

Bistorta alopecuroides, described from Eastern Siberia near Lake Baikal, occurs in the Russian Far East, Mongolia, northeast China and disjunctively on Jeju Island, Korea (Komarov, 1926, 1936; Nakai, 1938: Li et al., 2003). *Bistorta* *alopecuroides* is distinguished from closely related species by its glabrous, narrower basal and cauline leaves with rounded or cuneate base, and decurrent petiole. Its occurrence in Korea has been controversial. It was first reported from Korea (Jeju Island) by Nakai (1938). Nakai's treatment was followed by subsequent authors ((Park, 1974; Lee, 1980, Park and Hong, 2007). In contrast, the individuals of *Bistorta* with narrow lanceolate leaves on Mt. Halla, Jeju Island, have been treated as *B. vulgaris* var. *angustifolia* (Hayne) H. Gross or *B. major* var. *angustifolia* (Gross) Y. Lee (Gross, 1913a; Lee, 1996). Recently, Yonekura reported *B. officinalis* subsp. *japonica* (H. Hara) Yonek. (Yonekura, 2006) from Mt. Halla, which has further complicated the taxonomic identity of the *Bistorta* populations occurring there.

Bistorta pacifica was described by Komarov (1926) as *Polygonum pacificum* (Petrov ex Kom.) Kom. on the basis of specimens collected from Russian Far East. *Bistorta pacifica* is distinguished from closely related taxa on the basis of thick, ovate, basal leaves, cordate leaf base; and long petiole with vestigial wing (Komarov, 1926). *Bistorta pacifica* is in northeast China, Korea and the Russian Far East. Kitagawa (1972) was the first to recognize infraspecific taxa when he segregated pubescent plants of northeast China and Korea as *B. pacifica* f. *velutina* Kitag. Forma *velutina* has not been recognized by subsequent authors except by Lee (1996).

Plants distributed in northern Japan that appear to be closely related to *B. pacifica* have been recognized as *B. major* var. *ovata* (Nakai ex H. Hara) H. Hara (Hara, 1937). *Bistorta major* var. *ovata* was distinguished from related taxa on the basis of its ovate leaves, long, winged petioles, subsessile middle cauline leaves, absence of hairs and dense spicate inflorescence (Hara, 1934). *Bistorta major* var. *ovata* is occurs from from Hokkaido to central Honshu. Yonekura (2006), however, combined *B. major* var. *ovata* with *B. pacifica* and treated it as a synonym of *B. officinalis* Delarbre subsp. *pacifica* (Petrov ex Kom.) Yonek.

A plant closely related to the *B. manshuriensis* complex, *Bistorta major* var. *japonica* was described from Honshu of Japan (Hara, 1952). The diagnostic characters of *B. major* var. *japonica* include erect habit and glabrous, lanceolate leaves gradually tapering towards the apex. *Bistorta major* var. *japonica* occurs from central Honshu to Kyushu (Yonekura, 2006).

The five taxa of the complex are quite similar to each other in morphology, with the taxa distinguished mainly on the basis of the shape and size of the basal leaves, base of the leaf blade, length of petiole, width of wing on the petiole, length of the ochreae, shape of the inflorescence, and color of the perianth (Komarov, 1936; Nakai, 1938; Park, 1974; Lee, 1980; Lee, 1996; Li et al., 2003; Yonekura, 2006; Park and Hong, 2007). However, because of considerable variation and some degree of overlap in most distinguishing characters, there are different views on boundaries and relationships regarding the delimitation of these taxa. The taxonomic identity, pattern of divergence, and taxonomic relationship between the closely related taxa of different geographic region is poorly understood. For example, the relationship between the populations in Korea identified as *B. manshuriensis* are morphologically similar to *B. officinalis* subsp. *japonica* of Japan. Despite strong morphological affinities, however, they have been treated as separate taxa and their relationship has not been well understood. In contrast, the Korean individuals identified as *B. manshuriensis* are morphologically distinct from plants of *B. manshuriensis* in northeast China and Russian Far East, yet they have not been recognized as a different taxon. Moreover, the plants on Mt. Halla and along the southern coast of the Korean peninsula identified as *B. alopecuroides* show a number of morphological differences, such as plant height, shape and size of the leaves and width of the petiole wing from plants of *B. alopecuroides* in Mongolia, northeast China and Russian Far East. In addition, the relationship between *B. pacifica* of Korea, northeast China and Russian Far East and *B. major* var. *ovata* in Japan has also been controversial (Miyabe and Kudo, 1934; Hara, 1937; Yonekura, 2006).

There have been a few previous phylogenetic analyses of Polygonaceae based on chloroplast and nuclear DNA sequences with little representation from the genus *Bistorta*. Most of these studies have revealed *Bistorta* to be a strongly supported monophyletic group sister to the *Koenigia-Aconogonum* clade, however, with inadequate sampling none of these studies addressed phylogenetic relationships within *Bistorta* (Kim and Donoghue, 2008; Galasso et al., 2009; Sanchez et al. 2011; Schuster et al. 2011). Not surprisingly, none of these phylogenetic studies have included samples from the *B. manshuriensis* complex.

Chromosome number has been found useful in delimiting species in many species complexes in plants (Bardy et al. 2011; Marcussen and Borgen, 2011). Few counts of chromosome are known in *Bistorta*. Löve & Löve (1974; 1975) reported counts of $2n = 48$ for *B. major* and $2n = 72$ for *B. plumosa*. Counts from the species of *Bistorta* suggested base chromosome number of $x = 11, 12$ (Löve & Löve (1974; Karlsson, 2000; Freeman & Hinds, 2005). Diploids, tetraploids, hypotetraploids ($2n = 44, 46$) and hypertetraploids ($2n = 50$) have been reported in *Bistorta* (Doida, 1960; Löve, 1954; Löve & Löve, 1974; Goldblatt, 1988; Krogulevich & Rostovtseva, 1984; Krahulková, 1990). Among the taxa of the *B. manshuriensis* complex, *B. major* var. *ovata* has been reported to be tetraploid (2*n* = 4x = 48) and *B. major* var. *japonica* as both diploid (2*n* = 2x = 24) and tetraploid (Yonekura, 2006). The chromosome numbers of *B. manshuriensis* and *B. alopecuroides* is unknown.

Considering the variation in morphology and confusions in the circumscription of species in the *B. manshuriensis* complex, this study was carried out; 1) to clarify the taxonomic identities of the members of the *B. manshuriensis* complex based on morphological, cytological and molecular analyses, 2) to evaluate the degree of morphological variation in each of the taxa of the *B. manshuriensis* complex, 3) to infer phylogenetic relationships among the species of the complex based on chloroplast and nuclear DNA sequences, and 4) to provide a taxonomic treatment of the taxa of the complex based on the results.

II. Materials and Methods

Taxon sampling: Analysis of gross morphological characters of the *B. manshuriensis* complex and related species for this study was carried out by examining over 1300 separate specimens (i. e. not including duplicates) including type specimens. About 700 individuals were collected from Korea, Russia, Mongolia, China and Japan from 2007 to 2016. The specimens are deposited in the herbarium of Seoul National University (SNU). Type specimens and general collections were examined from National Institute of Biological Resources (KB), Kangwon National University herbarium (KNU), Warm-Temperate and Subtropical Forest Research Center, Korea (WTFRC), Komarov Botanical Institute (LE), University of Tokyo (TI), National Museum of Nature and Science, Tsukuba (TNS) and Harvard University Herbarium (HUH). Type specimens of nearly all names were studied, mostly through direct examination, or occasionally through online image databases or physical photographic images. All descriptions are based on herbarium specimens and field observations.

External morphology: In the present study, ca. 250 specimens covering all taxa of the complex and related taxa collected directly from field in Korea, China, Russia and Japan were analyzed. One hundred and fifty different specimens were used for numerical analyses.

Based on the type specimens and original descriptions, the diagnostic characters were identified, measured and analyzed. All measurements were based on herbarium specimens. Reproductive parts were rehydrated by putting in water at

60°C for 1 min prior to dissection. To avoid spatial variations, the same location on every plant was selected for measurement. Informations about distribution, habit, habitat, vernacular names, flowering, and fruiting periods were derived from herbarium specimen label data in combination with field observations. Herbarium specimen data were also used to verify consistency in characters. Fruit color was stated for mature fruits. Flowers and fruits were measured by using micrometer in dissecting microscope.

Anatomical study: To elucidate the differences on epidermal characteristics such as trichome morphology and distribution, shape and size of stomata, and epicuticular wax, the fresh plant material was collected and fixed in FAA for at least 48 hours. The fixed material was washed with distilled water and stored in 70% ethanol. For SEM observation, leaf samples were sectioned into small pieces ca. 0.5 x 0.5 cm with a razor blade. After dehydration in a graded ethanol and acetone series, the material was critical point dried with CO_2 using a Critical Point Drier (SPI 13200E-AB, SPI supplies, West Chester, PA, USA). The dried material was mounted onto aluminium stubs with double adhesive tape. Ion coater (Kressington Sputter Coater 108auto) was used for gold-coating for 45 sec in 40 mA and a low vacuum environment of 0.1 to 0.05 mbar. The above condition yielded in metal deposition of 1 nm/sl. Scanning Electron Microscope (JEOL JSM-6390LV) was used for observation and photographs at an acceleration voltage of 15kV.

Chromosome counts: Sixty-six accessions from 53 populations representing morphologically distinct groups of all taxa of the *B. manshuriensis* complex and the two closely related taxa from Japan were included in the chromosome counts. Chromosome counts were determined from root tip meristems. Individuals transplanted from the field to the greenhouse at Seoul National University were sampled for chromosomal study. In some cases, root tips directly collected from the field were used for chromosomal study. Root tips were pretreated in a solution of 0.1% colchicine (w/v) for 3–4 hours at room temperature and fixed in acetic alcohol (glacial acetic acid: absolute alcohol 1:3 v/v) for 30 min and macerated for 8 min in 1N HCl at 60°C. After washing in distilled water, root tips were stained for 30 min in 1.5% synthetic acetic orcein and squashed using the procedure of Darlington and LaCour (1976). Chromosome preparations were observed and photographed with an Olympus-BX50 microscope at 800–2000x. Voucher specimens are deposited in the herbarium of Seoul National University (SNU).

Principal Component Analysis (PCA): The data matrix for numerical analysis was obtained by considering each herbarium specimen as an OTU. Seventeen useful morphological characters were observed and measured. Table 1 shows the classes of quantitative characters adopted in the present study. Characters were standardized, so that each variable had a zero mean and a unit standard deviation.

In order to verify which of the variables account for most of the variation among groups and which characters are the most important in discriminating among species, PCA was applied for a complete data set containing all three taxa of the complex and related taxa. PCA was performed in microcomputer using SAS program (SAS Institute, 2011: Release 9.3), the correlation matrix was calculated and analyzed.

Table 1. Morphological characters selected for the principal component analysis (PCA) of the *B. manshuriensis* complex and related species

Leaf (basal leaf)

1. Leaf blade length (cm)
2. Leaf blade width at the widest point (cm)
3. Distance from leaf apex to the widest point of leaf (cm)
4. Leaf apex angle/2
5. Leaf base angle/2
6. Character 2/character 1
7. Blade width at 1/3 point of blade
8. Blade width at 1/2 point of blade
9. Blade width at 2/3 point of blade
10. Petiole length (cm)
11. Length of petiole wing (cm)
12. Width of petiole wing at 1/2 point of wing (cm)
13. Character 10/character1

Ochrea and leaf sheath

14. Ochrea length (cm)
15. Leaf sheath length (cm)
16. Character 15/character 14

Inflorescence

17. Inflorescence length (cm)

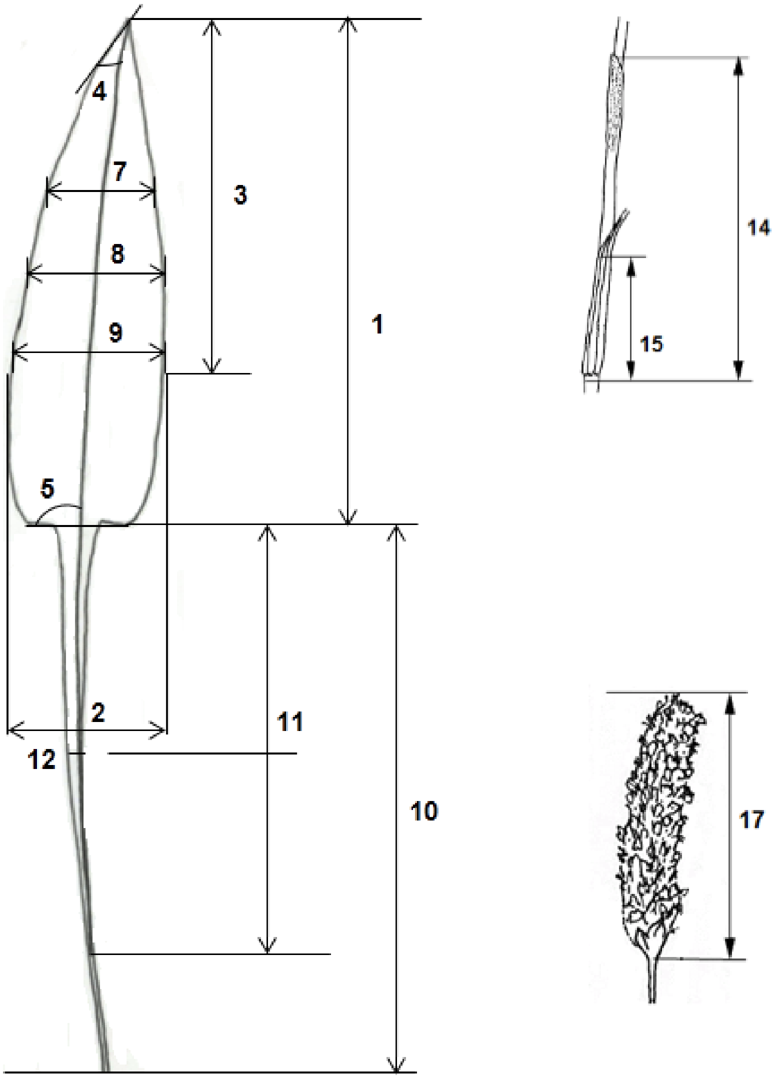

Fig. 1. Diagram showing characters measured for numerical analysis of the *B. manshuriensis* complex in northeast Asia. Numbers correspond to character numbers in Table 1.

Population sampling for molecular study: Fresh or silica-dried leaf materials of 182 accessions representing all three taxa of the *Bistorta manshuriensis* complex and two related taxa as well as two outgroup taxa were collected from 82 natural populations in northeast China, Japan, Korea, Mongolia and Russian Far East (Table 2). For the majority of taxa, two or more accessions from each population were analyzed. Two accessions of *B. suffulta* and one accession of *B. amplexicaulis* were selected as outgroup for molecular analysis. Voucher information, herbaria, and GenBank accession numbers of all species and sequences used in the molecular study are listed in Table 2. Voucher specimens of all accessions are deposited in SNU.

DNA extraction, PCR amplification, and sequencing: Genomic DNA from fresh or silica-dried leaf materials was extracted using DNeasy plant mini kit (Qiagen, Germany). Extracted DNA was separated on 1% agarose gel with ethidium bromide and quantified either by visual comparison of band intensities compared to standard size marker (*lambda* DNA cut with a double digest of *Hind*III and *Eco*RI) or through the use of NanoDrop 1000 Spectrophotometer (Thermo Scientific, Wilmington, DE 19810 U.S.A.). Sequences at different regions of genome evolve at different rates. Sequence data from two gene regions (*matK* and *ndhF*), two introns (*trnK* and *rpl16*) and two intergenic spacers (*psbA-trnH* and *rbcL-accD*) of cpDNA, and nuclear rDNA ITS were determined and analyzed in this study. Nuclear ITS and the six cpDNA regions, including *trnK* intron, *matK* gene, *psbA-trnH* IGS, *rpl16* intron, *ndhF* and *rbcL-accD* IGS, were amplified by polymerase chain reaction (PCR). Amplifications were conducted in 50 ul total volume reactions containing approximately 10–30 ng of genomic DNA. PCR was performed in GeneAmp PCR System 2400 (Perkin Elmer, Norwalk, Connecticut, USA) with standard protocol.

For the ITS region (ITS1, 5.8S, ITS2), ITS1 and ITS4 primers (White et al., 1990) were used. The PCR cycle profile comprised an initial step of 98°C (3 min), 35 cycles with 1 min denaturation at 95°C, 30 s annealing at 54°C, and 45 s extension at 72°C, and a final 7 min extension step at 72°C. The thermal conditions for *trnK* intron, *matK* gene, *rpl16* intron and *ndhF* gene was as follows: an initial denaturation step at 95°C for 3 min, followed by 35 cycles of 1 min denaturation at 95°C, 30 s annealing at 51–52°C and 75 s extension at 72°C, and a final extension step at 72°C for 7 min. The thermal conditions were similar for *psbA*-*trn*H IGS and *rbcL-accD* IGS regions except that the annealing temperature was 55°C for *psbA-trnH* IGS and 50°C for *rbcL-accD* IGS and extension time was 45 s in both. The primer pairs used to amplify all six cpDNA sequence regions examined are listed in Table 3.

The PCR products were visualized (checked) on 1% agarose gel and successful amplifications were cleaned by 1-hour digestion at 37°C with 2 units of exonuclease I and 2 units of SAP (Affymetrix, Ohio, USA) following the procedure of Werle et al. (1994). Cycle sequencing reactions were performed for the purified PCR products using BigDye Terminator Cycle Sequencing Ready Reaction Kit (ver 3.1, Applied Biosystems, Foster City, CA, USA) following the manufacturer’s instructions. Sequencing primers used were identical to the amplification primers. However, an additional internal sequencing primer was used for sequencing in *matK*. The sequencing reaction conditions were as follows: 94°C for 1 min;

followed by 25 cycles of 96°C for 10 s, 50°C for 5 s, and 60°C for 4 min; and subsequent storage at 4°C. Sequencing reactions were purified through ethanol/sodium acetate precipitation method, air-dried and sent to the DNA Sequencing Facility at Seoul National University or Macrogen, Korea where gels were run using an ABI 3730 DNA analyzer (Applied Biosystems, CA, USA).

DNA Data Analysis: Forward and reverse sequence reads were edited and assembled into contigs in Sequencher 5.1 (Gene Codes Corp., Ann Arbor, Michigan). Alignment was straightforward for *trnK* intron, *matK* gene and *ndhF* gene across the taxa of the complex but the introns (*trnK* and *rpl16*) and the spacers (*psbA-trnH* IGS and *rbcL-accD* IGS) showed length variablility. Sequences were initially aligned in Clustal X version 1.81 using default alignment parameters (Thompson et al., 1997). The resulting alignments were checked and refined manually Se-Al ver. 2.0a11 (Rambout, 2002) to optimize homology. Alignment gaps were treated as missing data. Each indel was considered to have originated independently. A 180 bp region in *psbA-trnH* consisting of microsatellite motif variations and tandem repeats couldn’t be aligned unambiguously and hence, excluded from the analysis. One inversion was inferred in the *psbA-trnH* IGS: a 30-bp stretch between positions 1870–1899 in some accessions identified as *B. manshuriensis* and *B. alopecuroides*. The inversion was reverse complemented in the alignment to reflect the ancestral orientation and included in the analyses (Graham et al., 2000; Lohne and Borsch, 2005; Ochoterena, 2009; Davis and Soreng, 2010; Cohen and Davis, 2012).

Table 2. Population code, locality, collection number, number of individuals investigated and haplotypes observed for 182 accessions of the *B. manshuriensis* complex and closely related taxa examined in this study (outgroup taxa included). All vouchers are deposited in SNU. Specific localities of the accessions sampled from northeast China, Japan, Korea, Mongolia, and Russian Far East are shown in Fig. 2. Asterisk indicates population-specific haplotype.

Population code	**Locality and collection number**	**No. of individuals**
B. manshuriensis		
M1	RUSSIA. Khabarovsk Krai, Sovetscaya, *Komarov 64*	1
M2	RUSSIA. Primorsky, Khankaysky District, vicinities of Tury Rog village, near Khanka Lake, *Park et al. 114, 117, 118*	3
M3	RUSSIA. Primorsky, Khankaysky District, vicinities of Komissarovo settlement, *Park et al. 65–68, 70–72, 76, 80–92, 94, 95, 97–101, 103, 104*	30
M4	RUSSIA. Primorsky, Khankaysky District, vicinities of Ilyinka village, on the mixed meadow, *Park et al. 63*	1
M5	RUSSIA. Primorsky, near Olenevad, *Park & Choi 54*	1
M6	RUSSIA. Primorsky, Russia Island, *Park & Choi 32, 35*	2
M7	CHINA. Heilongjiang, *Bhandari & Choi 7*	1
M8	CHINA. Heilongjiang, *Bhandari & Choi 13-1, 39-1, Park & Choi 74*	3
M9	CHINA. Heilongjiang, *Bhandari & Choi 47*	1
M10	CHINA. Neimongol, *Lee 5*	1
M11	CHINA. Jilin, Ussulin, *Park & Choi 28*	1
M12	CHINA. Jilin, Sunburyeong, *Park & Choi 67, 72*	2

Table 2. (Continued).

Population code	**Locality and collection number**	**No. of individuals**
Korean accessions identified as *B. manshuriensis*		
M13	KOREA. Gangwon, Mt. Odae, Jingogae, *Bhandari 101*	1
M14	KOREA. Gangwon, Mt. Odae, Jilmaenuf, *Suh 15523, Bhandari 1562-1, -3*	3
M15	KOREA. Gangwon, Daegwanryeong, *Suh & Bhandari 15*	1
M16	KOREA. Gangwon, Mt. Daerung, *Bhandari & Kim 110903-52*	1
M17	KOREA. Kyeonggi-do, Mt. Suwon, *Bhandari 15717-2, -4*	2
M18	KOREA. Ganghwado, Mt. Hyeolgu, *Park & Kim 11072*	1
M19	KOREA. Kyeonggi-do, Gimpo-si, Mt. Gahyeon, *Bhandari 8031*	1
M20	KOREA. Kyeonggi-do, Namhansanseong, *Bhandari 12715-2, 16724-1*	2
M21	KOREA. Chungnam, Guraepo, *Bhandari 15714-18*	1
M22	KOREA. Chungnam, Manripo, *Bhandari 1105*	1
M23	KOREA. Chungnam, Seosan, Mt. Buchhun, *Suh & Bhandari 15714-5*	1
M24	KOREA. Chungnam, Mt. Oseo, *Bhandari 1573-1*	1
M25	KOREA. Chungnam, Mt. Oseo, *Bhandari 802, 808, 810, 815*	4
M26	KOREA. Chungbuk, Mt. Seondo, *Bhandari 1052*	1
M27	KOREA. Daegu, Gasansanseong, *Bhandari 7772, 7774*	2
M28	KOREA. Gyeongbuk, Mt. Biseul, *Bhandari 1001, 1002, 1010*	3
M29	KOREA. Gyeongnam, Mt. Jongnam, *Won 622*	1
M30	KOREA. Gyeongnam, Mt. Bulmo, *Park & Bhandari 5581, Won 579*	2

Table 2. (Continued).

Population code	**Locality and collection number**	**No. of individuals**
M31	KOREA. Gyeongnam, Mt. Jagul, *Bhandari 7754, 7762*	2
M32	KOREA. Gyeongnam, Mt. Mita, *Bhandari & Choi 127914*	1
M33	KOREA. Gwangju, Mt. Mudeong, *Bhandari 8055, 8057*	2
M34	KOREA. Jeollabuk, Mt. Duryun, *Bhandari 7022, 7030*	2
M35	KOREA. Jeonnam, Mt. Sammun, *Bhandari 7015, 7017*	2
B. pacifica		
P1	RUSSIA. Primorsky, Lazovsky District, near the marine biological station (Zapovednoye), *Doudkin 1–4*	4
P2	RUSSIA. Primorsky, Nakhodka, *Park et al. 12, 17*	2
P3	RUSSIA, Primorsky, *Park et al. 120624_4*	1
P4	RUSSIA. Primorsky, *Park et al. 94, 98*	2
P5	RUSSIA. Primorsky, Shkotovsky District, vicinities of Rechitsa village, *Park et al. 1–3*	3
P6	RUSSIA. Primorsky, Shkotovsky District, vicinities of Rechitsa village, *Park et al. 5–9*	5
P7	RUSSIA. Primorsky, Ussurisky, *Park & Choi 107, 108*	2
P8	RUSSIA, Primorsky, *Park et al. 120625_38-2*	1
P9	RUSSIA, Primorsky, *Park et al. 120625_1-4*	1
P10	CHINA. Jilin, *Choi 10, 11*	2
P11	CHINA. Jilin, *Choi 27, 30*	2
P12	CHINA. Jilin, Sunburyeong, *Park & Choi 53, Lee 2*	2
P13	CHINA. Jilin, *Oh et al. 145, 148*	2

Table 2. (Continued).

Population code	**Locality and collection number**	**No. of individuals**
P14	KOREA. Gyeonggi, Mt. Hwaak, *Bhandari 202, 205*	2
P15	KOREA. Gangwon, Inje, Mt. Daeam, *Suh & Bhandari 823-6, 823-10, Suh 1584-7*	3
P16	KOREA. Gangwon, Mt. Seorak, *Won & Bhandari 401–404, Bhandari 16621-1, 4, 6, 15*	8
P17	KOREA. Gangwon, Mt. Sowhangbyeong, *Bhandari & Suh 628-4*	1
P18	KOREA. Gangwon, Mt. Gyebang, *Bhandari 12724-09,11*	2
P19	KOREA. Gangwon, Mt. Gariwang, *Bhandari 151, 157, 169*	3
P20	KOREA. Gangwon, Mt. Cheongok, *Lee 650*; *Bhandari 1403*	2
P21	KOREA. Gangwon, Hongcheon, *Suh 1571-1*	1
P22	KOREA. Gangwon, Mt. Hambaek, *Bhandari 7079*	1
P23	KOREA. Gangwon, Mt. Hambaek, *Bhandari 7086*	1
P24	KOREA. Gangwon, Mt. Hambaek, Manhangje, *Suh 1575-1*	1
P25	KOREA. Gangwon, Mt. Taebaek, *Bhandari 702, 703*	2
P26	KOREA. Gangwon, Mt. Taebaek, *Bhandari 704*	1
P27	KOREA. Chungbuk, Mt. Sobaek, *Bhandari 4, 9, 15,40,53, 55*	6
P28	KOREA. Gyeongbuk, Mt. Ilwol, *Bhandari 11726-7*	1
P29	KOREA. Chungbuk, Mt. Minjuji, *Bhandari 1501, 1505*	2
P30	KOREA. Jeollabuk , Mt. Deokyu, *Bhandari 11103*	1
P31	KOREA. Jeollabuk, Mt. Jiri, *Bhandari 521*	1
P32	KOREA. Jeollabuk, Mt. Jiri, *Bhandari 532*	1

Table 2. (Continued).

Population code	**Locality and collection number**	**No. of individuals**
Korean populations identified as *B. alopecuroides*		
A1	KOREA. Gyeongnam, Mt. Gara, *Park & Bhandari 609, 6603*	2
A2	KOREA. Jeju, Ara, Samgakbong, *Bhandari & Kim 3106, 3108, Bhandari & Gao 3004*; *Won & Bhandari 330*	4
A3	KOREA. Jeju, Mt. Halla, Witseoreum, *Bhandari & Kim 3078, 3080, Kim 0904-1, 3*	4
A4	KOREA. Jeju, Mt. Halla, Yeongsil course, *Bhandari & Kim 3064*	1
A5	KOREA. Jeju, Mt. Halla, Baekrokdam, *Won & Bhandari B1, B3*, *B5*, *B7*	4
A6	KOREA. Jeju, Mt. Halla, Seongpanak course, *Bhandari 3013*	1
B. alopecuroides		
A7	MONGOLIA. Khentii, *Lee 1*	1
A8	MONGOLIA. Arkhangai, *Park & Kim B9*	1
B. major var. *major*		
B1	CHINA. Beijing, *Kwak 1*	1
B2	UK (transplanted at Royal Botanic Garden Edinburgh)	1
B. major var. *japonica*		
J1	JAPAN. Honshu, Nikko, *Park et al. 197*, *198*	2
J2	JAPAN. Kyushu, *Im 2*	1
J3	JAPAN	1
B. major var. *ovata*		
O1	JAPAN. Hokkaido, Rebun Island, *Suh 1*	1
O2	JAPAN. Hokkaido, Mt. Obira, *Kim 29–32*	4

Table 2. (Continued).

Population code	**Locality and collection number**	**No. of individuals**
B. amplexicaulis		
A1	CHINA. *Kim CY2001-084*	1
B. suffulta		
S1	KOREA. Jeju, Mt. Halla, *Won & Bhandari 321*	1
S2	KOREA. Jeju, Mt. Halla, *Bhandari 3391*	1

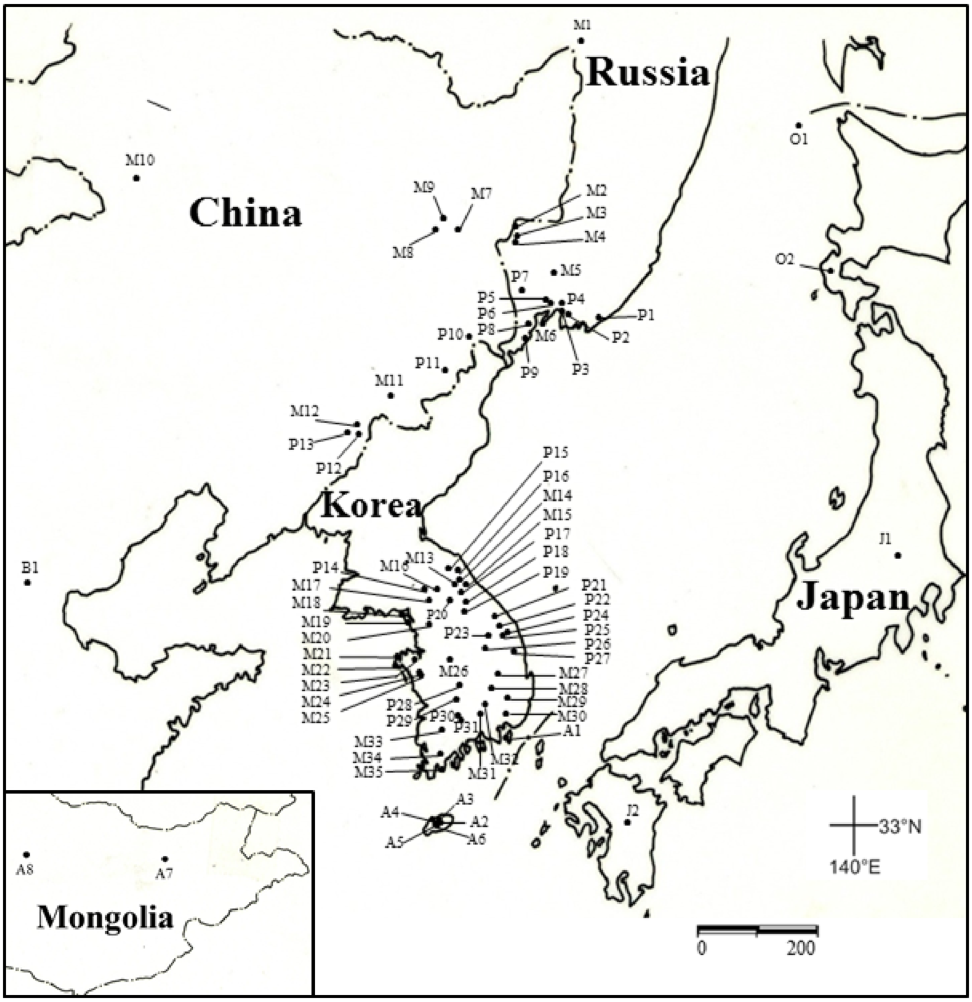

Fig. 2. Collection sites of the *B. manshuriensis* complex and related taxa used in this study. The population codes correspond to the population codes in Table 2.

Table 3. Primers used for PCR amplification and sequencing in this study. Primer names with asterisk (*) indicate primers used only for sequencing.

Region	Primers	Sequence (5’→3’)	Reference
Nuclear DNA			
ITS	ITSK1	TCGTAACAAGGTTTCCGTAGGT	Kim, pers. comm.
	ITS4	TCCTCCGCTTATTGATATGC	White et al. (1990)
Chloroplast DNA			
trnK	trnK3914F	GGGGTTGCTAACTCAACGG	Johnson & Soltis (1994)
	matk479R	ATGGATAGGGTGAGGTATC	Present study
matK	trnK670F	CTGTATCGCACTATGTATC	Kim (2007)
	matK1246R	CCGCTGTAATAATGAGAAAG	Kim (2007)
	matK193F*	GTTATTCGAATGTATCAACAG	Kim (2007)
	matK520R*	CTCATGCTTGCATTTATTACG	Kim (2007)
psbA-trnH	psbAF	GTTATGCATGAACGTAATGCTC	Sang et al. (1997)
	trnHR	CGCGCATGGTGGATTCACAATC	Sang et al. (1997)
rpl16	L16 exon1	AATAATCGCTATGCTTAGTG	Downie et al. (2000)
	L16 exon2	TCTTCCTCTATGTTGTTTACG	Downie et al. (2000)
ndhF	ndhF1F	ATGGAACAKACATATSAATATGCGTGG	Olmstead & Sweere (1994)
	ndhF1314R	GCGAAACATATAAAATGCTGTTAATCC	Present study
	ndhF7F	AGGTACACTTTCTCTTTCTGGTA	Olmstead & Sweere (1994)
	ndhF2110R	CTAYATATTTGATACCTTCTCC	Olmstead & Sweere (1994)
rbcL-accD	rbcL50F	GAAGTATGGAAGGAAATCA	Yasui & Ohnishi (1998)
	accD79R	ACAACATCGAATTAAACCAC	Kim (2007)

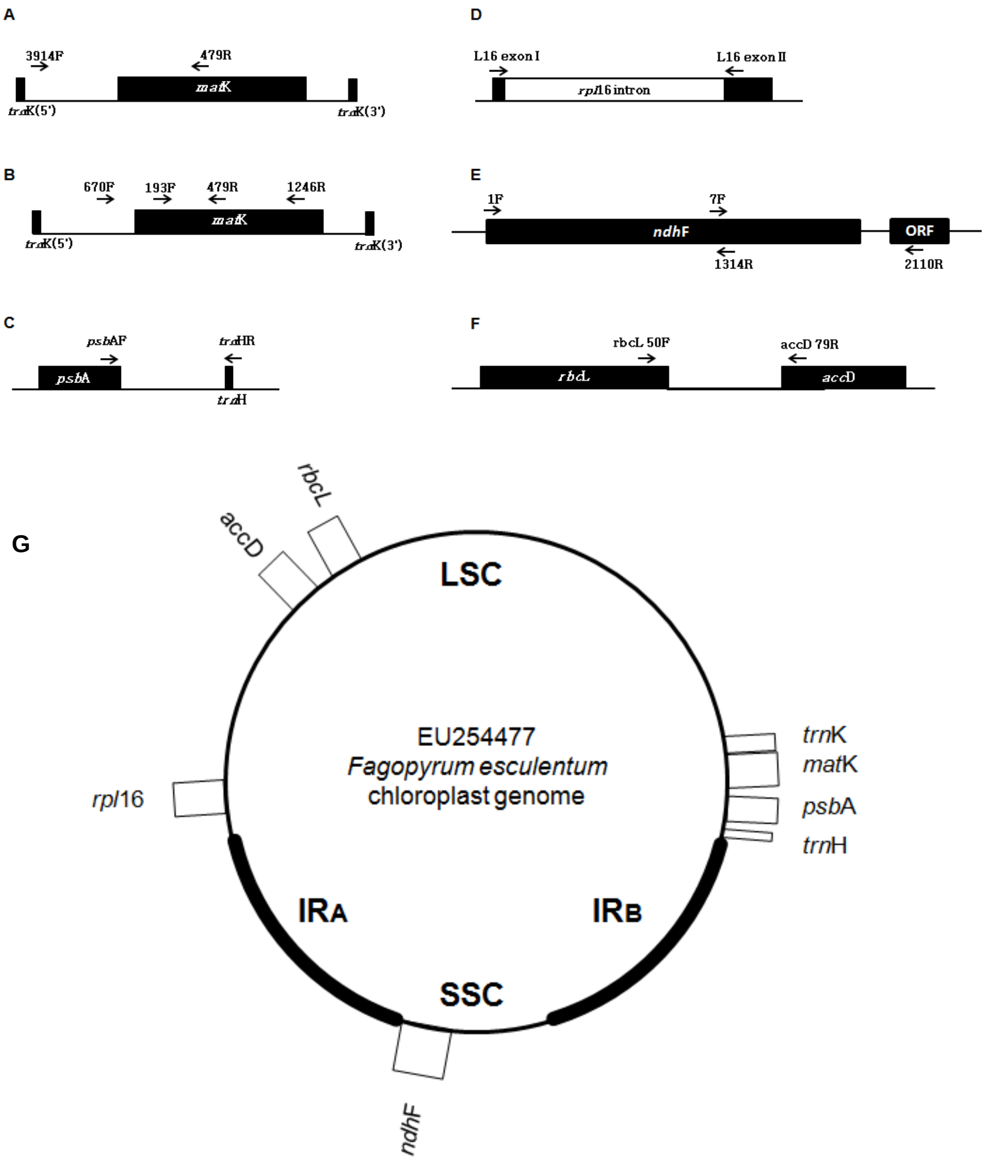

Fig. 3. The organization of six chloroplast regions (A–F) analyzed in this study and their positions in the chloroplast DNA (G) represented in the gene map of *Fagopyrum esculentum* genome (cf. Logacheva et al., 2008). Arrows indicate orientation and approximate position of primer sites used for PCR amplification and sequencing.

Phylogenetic analyses: Tree analyses were performed using PAUP 4.0b10 (Swofford, 2003). Nuclear ITS and cpDNA regions were analyzed separately. The six DNA regions were analyzed separately and also for combined data set. All characters were treated as unordered and weighted equally. Neighbor-Joining (NJ) analysis (Saitou and Nei, 1987) was employed to infer phylogenetic relationship.

The NJ tree was constructed using Kimura 2-parameter distance (Kimura, 1980). To search for the shortest trees, Maximum Parsimony (MP) analyses were performed using heuristic search with 100 replicates, random sequence addition with tree bisection and reconnection (TBR), holding 10 trees per replicate, MAXTREES set to no limit, ACCTRAN character optimization and MULTREES option in effect. Those shortest trees were used to generate a strict consensus tree. All characters were unweighted and unordered; positions containing insertions/deletions (indels) were excluded prior to all phylogenetic analyses. Consistency and retention indices were calculated in PAUP. Bootstrap (BS) analyses were performed to evaluated support for specific branches or clades (Felsenstein, 1985). BS values were calculated with 1,000 replicates under the same conditions with the exception that MAXTREES was set to 1,000. BS values 50% or above were reported.

Bayesian analyses were performed with MrBayes version 3.2 (Ronquist et al., 2012) with two simultaneous Markov Chain Monte Carlo (MCMC) runs of four chains. Substitution models for each gene were determined with mrmodeltest 2.3 (Nylander, 2004). One million generations were run with sampling every 100th generation and first 25% of trees discarded as burnin. The remaining trees were used to produce a 50% majority-rule consensus tree and determine posterior probabilities (PP). Analyses were run until the value of the average standard deviation of split frequencies dropped below 0.01.

Network Analysis: The combined data set of the three selected plastid regions (*trnK* intron, *matK* and *ndhF*) was also used for TCS network analysis using all informative sites. TCS was developed for population genetic data, where phylogenetic divergences are often low, ancestral haplotypes are typically extant, and multifurcations are common (Templeton et al., 1995; Posada and Crandall, 2001). In order to resolve haplotype relationships within the *B. manshuriensis* complex, a haplotype network was constructed by using TCS 1.21 (Clement et al., 2000). The 95% probability limit of parsimonious connections was applied to produce the network.

Table 4. List of acronyms representing localities in this study.

Acronym	Locality
bc	Mt. Buchhun
bj	Beijing
bl	Mt. Bulmo
bs	Mt. Biseol
ck	Mt. Cheong-ok
cn	China
dg	Daegwanryeong
dk	Mt. Deokyu
dm	Mt. Dae-am
dn	Mt. Duryun
dr	Mt. Daerung
gb	Mt. Gyebang
gn	Gasansanseong
gr	Mt. Gara
gy	Mt. Gahyeon
gu	Guraepo
gw	Mt. Gariwang
hb	Mt. Hambaek
hc	Hongcheon
hg	Mt. Hyeolgu
hj	Heilongjiang
hk	Hokkaido
hn	Honshu
hl	Mt. Halla
hw	Mt. Hwa-ak
il	Mt. Ilwol
jg	Mt. Jagul
jl	Jilin

Table 4. (Continued).

Acronym	Locality
Jm	Jilmaenuf
jn	Mt. Jongnam
jp	Japan
jr	Mt. Jiri
kb	Khabarovsk
kh	Khanka
kr	Korea
ky	Kyushu
mc	Mangcheoneo
md	Mt. Mudeong
mh	Manhangje
mj	Mt. Minjuji
mn	Mongolia
mp	Manripo
ms	Marine station
mt	Mt. Mita
nh	Namhansanseong
nm	Neimongol
nk	Nakhodka
od	Mt. Odae
os	Mt. Oseo
ot	Olenevad-Tikhoye
pr	Primorsky
rb	Rebun Island
rc	Rechitsa
ri	Russia Island
rs	Russia
sb	Seonburyeong
sh	Mt. Sohwangbyeong

Table 4. (Continued).

Acronym	Locality
sk	Mt. Seorak
sm	Mt. Sammun
sn	Mt. Seondo
so	Mt. Sobaek
sw	Mt. Suwon
tb	Mt. Tabebaek
uk	United Kingdom
ul	Ussulin
us	Ussurisky

III. Results

1. Morphology

The genus *Bistorta* is readily distinguished from other genera of Polygonaceae by its perennial habit, stout and often contorted rhizome, basal leaf-rosettes, revolute leaf margin with broad nerves on the edges, cylindrical and oblique ochrea, terminal or terminal and axillary spike-like cyme with dense flowers, five-parted perianth, eight free stamens, fusion of nectaries with the base of inner stamens, and tricolpate pollens (Greene, 1904; Gross 1913b; Hedberg, 1946; Haraldson, 1978; Ronse Decrane and Akeroyd, 1988).

Habit: Species of *Bistorta* are rhizomatous, herbaceous perennials or subshrubs that rarely attain more than 1.4 m in height. The species are erect, ascending, prostrate or creeping. The habit is one of the main basis for infrageneric classification by Petrov (1928). All taxa of the *B. manshuriensis* complex are erect, herbaceous perennials. Plant height usually ranges from 0.6—1.2 m at maturity. Plant height varies with the age of the plant as well as environmental conditions within and among the species of the complex. The plants growing in open grasslands are generally shorter than the plants growing under the forest. Habit appears to be of little taxonomic significance in distinguishing the taxa of the *B. manshuriensis* complex.

Rhizomes: The shape and size of rhizome provided one of the main basis for infrageneric classification in *Bistorta* by Petrov (1928) and Yonekura (2006). Three types of rhizomes have been described in *Bistorta*: 1) short, stout, unbranched, tortuous or rarely tuberous found (subgen. or sect. *Bistorta*), 2) cylindrical, moniliform and branched (subgen. *Bistortella* Petrov or sect. *Bistortella* (Petrov) Yonek.), and 3) thin, ligneous, branched and stoloniferous (subgen. *Pseudobistorta* Petrov). In the taxa of the *B. manshuriensis* complex, rhizomes are short, simple, stout, tortuous, non-torulose, and covered with fibrous remnants of radical leaves. Fibrous roots arise from the lower surface of the rhizome. The rhizome appears blackish outside and reddish brown inside. The size of rhizomes was variable across the taxa and populations in the complex. The rhizomes of *B. manshuriensis* individuals collected from northeast China as well as Olenevad and Russia Island of Russian Far East were the smallest in the complex with an average diam. of ca. 0.5 cm. The largest rhizomes were found in the individuals of *B. major* var. *ovata* with an average diam. of ca. 3 cm.

Stems: In *Bistorta*, the stems are mainly of two types– herbaceous and simple (subgen. *Bistorta* and subgen. *Bistortella* Petrov) or woody and branched (subgen. *Pseudobistorta* Petrov). The woody forms have black-brown bark in the stem. The stems are 1–4 mm in diam. In all taxa of the *B. manshuriensis* complex, stems are herbaceous, simple, erect, cylindrical, glabrous and pale green. The plants have hollow pith. The stems are 2–4 mm in diam. In an individual, the number of stems arising from rhizome varied from one to 10 in the complex. The number of stem was one to two in the *B. manshuriensis* from northeast China and Olenevad and Russia Island of Russian Far East, and eight to 10 in the individuals identified as *B. alopecuroides* collected from Mt. Gara of Korea. There were four to 10 nodes in a stem in the taxa of the *B. manshuriensis* complex. The number of nodes was presented as one of the key characters in series *Bistorta* by Komarov (1936).

However, the number of nodes in a stem varied across populations within species and even within populations and did not show any definitive pattern of variation in this study. Hence, number of nodes in a stem appears to be of little taxonomic significance.

Leaves: In *Bistorta*, basal (radical) leaves arise from rhizome. The basal leaves are rosulate, several to many, simple, ascending and long or short petiolate. The basal leaves are densely tufted in some species including *B. affinis*. The shape of the leaf blade can be linear, lanceolate, oblanceolate, elliptic or ovate. The shape of basal leaf blade showed considerable intraspecific variation, but was still regarded as the most important diagnostic character in *Bistorta* (Komarov, 1926, 1936; Nakai, 1938; Park, 1974; Lee, 1980; Lee, 1996; Yonekura, 2006; Park and Hong, 2007). In the members of the *B. manshuriensis* complex, the shape of leaf blade was linear, lanceolate or ovate. Basal leaves were absent in the individuals of *B. manshuriensis* of some populations of northeast China and Russian Far East. As these individuals had smallest rhizomes in the *B. manshuriensis* complex, the presence or absence of basal leaves appears to be correlated to the size of the rhizome. In the *B. manshuriensis* complex, length of basal leaf (character 1, Fig. 4) was 8.4–34.1 cm and maximum width (character 2, Fig. 4) was 0.60–12.9 cm. This large variation in leaf size appears to have resulted from variations in environmental conditions. The leaf blades of the Korean individuals identified as *B. manshuriensis* were 13.6–34.1 cm (averag 20.5 cm) long and 1.7–9.8 cm (average 5 cm) wide, representing longest basal leaves in the complex. In *B. pacifica*, the leaf blades were 9.5–21.2 cm (average 14.6 cm) long and 3.3–12.9 cm (average 6.5 cm) and in *B. major* var. *ovata* the blades were 13.1–18.4 cm (average 16.9 cm) long and 6.4–10.6 cm (average 9 cm) wide, indicating that these taxa had the wider leaves compared to other taxa of the complex. The leaf blades of Korean specimens identified as *B. alopecuroides* were 8.4–21.8 cm (average 14.2 cm) long and 0.6–3.6 cm (average 2 cm) wide and thus had narrower leaves than the other taxa of the complex. However, as there was wide variation in length and width of basal leaves within a species and these differences were overlapping among the taxa, these taxa were not revealed as taxonomically distinct on the basis of basal leaves.

The shape of the leaf blade of basal leaves varied from linear, lanceolate to ovate in the taxa of the *B. manshuriensis* complex. The width/length ratio of basal leaves was 0.05–0.23 (average 0.14) in the Korean individuals identified as *B. alopecuroides*, and this species was distinguished from other taxa of the complex by its linear to narrowly lanceolate basal leaves (Fig. 5). The width/length ratio of basal leaves was 0.09–0.44 (average 0.25) for *B. manshuriensis*. This species had lanceolate to narrowly ovate basal leaves and tend to have wider basal leaves than *B. alopecuroides*. The other two taxa, *B. pacifica* and *B. major* var. *ovata,* had narrowly ovate to widely ovate basal leaves with width/length ratio of 0.29–0.91 (average 0.45) for and 0.49–0.58 (average 0.53) respectively. The shape of basal leaves was similar in *B. pacifica* and *B. major* var. *ovata*. The leaf apex of basal leaf was acute or acuminate in the taxa of the complex. The leaf apex angle (half angle) of basal leaf varied from 3° to 53° in the individuals of the complex. *Bistorta alopecuroides* and *B. manshuriensis* tend to have acuminate leaf apex with the apex angle (half angle) varying from 3° to 26° (average 10) in *B. alopecuroides* and 6° to 35° (average 14.8°) in *B. manshuriensis*. *Bistorta pacifica* and *B. major* var. *ovata* tend to have acute leaf apex with the apex angle (half angle) varying from 19° to 41°

(average 32.8°) in *B. pacifica* and 7° to 53° (average 26.7°) in *B. major* var. *ovata*.

The base of the basal leaf blade was cuneate, rounded to truncate in the complex. The leaf base angle (half angle) varied from 10° to 172° in the *B. manshuriensis* complex. The leaf base of the Korean specimens identified as *B. alopecuroides* was cuneate to rounded with the base angle 13°–83° (average 48.4°). the leaf base was cuneate, truncate to subcordate in the Korean specimens identified as *B. manshuriensis* with the base angle ranging from 10°–120° (average 71.8°). In *B. pacifica* and *B. major* var. *ovata* the leaf base was cordate with the base angle ranging from 71°–172° (average 122.2°) and 90°–128° (average 106°) respectively.

The network of veins was raised and prominent in the abaxial leaf surface of *B. major* var. *ovata* as well as in some populations of *B. pacifica*. In contrast, the network of veins was not raised and less prominent in *B. manshuriensis* and *B. alopecuroides*. This character was used as an important diagnostic character to distinguish *B. pacifica* from other taxa of *Bistorta* (Komarov, 1926; 1936).

The leaf margin was entire in *B. alopecuroides* or strongly undulate in *B. major* var. *ovata*. The edge of the margin was generally revolute with thickened veins in the taxa of the complex. Veinlets were swollen, expanded, recurved and falcate at the margin of leaf blade. However, thickening of veinlets at the edge of the the leaf margin of *B. manshuriensis* collected from Russian Far East and northeast China, as well as the specimens collected from Mt. Odae of Korea was not prominent. Hence, the presence or absence of thickened veins at the leaf margin is useful in distinguishing some taxa of the complex. Basal leaves and lower cauline leaves usually had long petiole. The length of petiole ranged from 7.8 cm to 53 cm in the complex. Petioles were generally shorter in Korean individuals identified as *B. alopecuroides* compared to other taxa of the complex, ranging from 7.8-30.9 cm (average 16.7 cm). The length of petiole varied from 21.8 cm to 48 cm in *B. manshuriensis*, from 16.9 to 53 cm (average 33 cm) in *B. pacifica* and from 24.5 cm to 40 cm (average 33.6 cm) in *B. major* var. *ovata*. Thus, the average petiole length was nearly identical in *B. manshuriensis*, *B. pacifica* and *B. major* var. *japonica*.

The leaf blade of basal leaves are decurrent forming a wing-like outgrowths in upper part of petiole in most species of *Bistorta*. Presence or absence of petiole wing is useful in distinguishing some species in *Bistorta* (Komarov, 1936; Li et al. 2003; Yonekura, 2006). In all taxa of the *B. manshuriensis* complex, the upper part of petiole is winged. The length of wing in the petiole ranged from 1.4 cm to 24.8 cm in the complex. The wings were poorly developed in the Korean individuals of *B. pacifica* compared to Russian and Chinese individuals. The average width of petiole wing in ½ point of petiole wing was substantially lower in *B. pacifica* compared to other taxa of the complex (Fig. 6). Hence, the broadness of the wing in the petiole of basal appears to be useful to distinguish *B. pacifica* from other taxa of the complex. The petiole consisted of a well-developed cylindrical sheath at its base.

Cauline leaves were simple and alternate. Lower cauline leaves were petiolate with short leaf sheath at its base, and were disintegrating with age. The shape of leaf blade of lower cauline leaf and radical leaves was similar. Cauline leaves tend to be gradually smaller toward the upper part of the stem. Middle and upper cauline leaves were sessile, usually deeply amplexicaul, and with long cylindrical greenish sheath at the base. Middle leaves were ovate to lanceolate and the upper leaves were lanceolate or linear. The uppermost leaf was usually linear or filifom.

Pubescence of leaves: In *Bistorta*, the abaxial leaf surface is glabrous or pubescent. Pubescence of leaves has been used as a diagnostic character in distinguishing some species of *Bistorta* (Komarov, 1936; Nakai, 1938; Li et al. 2003; Park and Hong, 2007). The taxa of the *B. manshuriensis* complex had glabrous or pubescent basal leaves. Basal leaves were glabrous in all Russian and Chinese specimens of *B. manshuriensis* and most Korean specimens identified as *B. manshuriensis*. Individuals from three populations of Mt. Odae were found to have densely pubescent abaxial leaf surface. Basal leaves of all individuals of Chinese populations and a majority of Russian populations of *B. pacifica* were densely pubescent abaxially. In contrast, the leaves of Korean individuals of *B. pacifica* were generally glabrous. The individuals of *B. major* var. *ovata* were glabrous. The abaxial leaf surfaces of individuals of Mongolian population of *B. alopecuroides* were also densely pubescent. In contrast, Korean specimens identified as *B. alopecuroides* were generally glabrous. Thus, leaf pubescence appears to be a useful character in distinguishing some taxa of the complex.

Ochreae: In *Bistorta*, ochreae of cauline leaves are tubular, membranous, nerved, brown distally, green basally, and completely surrounding the nodes. The ochreae are easily lacerate, oblique, cleft to the middle or base, and eciliate at tips. In the the *B. manshuriensis* complex, the length of ochrea in lower cauline leaves ranged from 2.2–13.5 cm. Ochreae were cleft, but never to the base. Ochreae were generally glabrous in the complex. Ochreae of upper leaves were truncate apically. Ochrea of lowermost 1–2 cauline leaves disintegraded with age.

Inflorescences: In *Bistorta*, inflorescences are simple and usually terminal.

In some species, the inflorescences are terminal and axillary. The inflorescence consists of primary monochasia (helicoid cyme) arranged in spike-like secondary inflorescences. The monochasia arise from the node of spike. Each monochasium consists of 1–5 flowers, and is subtended by small brown bract. Each monochasium is surrounded by a pair of scarious and hyaline bracteoles. In some species including *B. vivipara*, the monochasia in the lower part of the inflorescence are replaced by bulbils. The number of flowers in the monochasia is an important diagnostic character (Yonekura, 2006). In the taxa of the *B. manshuriensis* complex, the number of flowers in each monochasium was 2–5. In *B. manshuriensis*, two or three flowers were found in each node. However, four flowers were found in each node in the individuals collected from populations in Gasansanseong, Mt. Mudeong and Mt. Buchhun of Korea, and five flowers were present in each node in the individuals collected from a population in Manripo of Korea. In the Korean individuals of *B. pacifica*, the number of flowers in each node was two or three. In contrast, in the Chinese and Russian individuals of *B. pacifica* as well as in *B. major* var. *ovata*, the number of flowers in each node was usually two. In *B. alopecuroides*, the number of flowers in each node was two or three. Thus, the number of flowers in each node was usually variable among populations within a species.

In *Bistorta*, the shape of the inflorescence is usually cylindrical and sometimes, globose. The shape of the inflorescence is a useful diagnostic character in distinguishing *B. globispica* from other species of *Bistorta* (Nakai, 1938; Park and Hong, 2007). In all taxa of the *B. manshuriensis* complex, the inflorescence was cylindrical with the length varying from 1.7 cm to 11.8 cm. Among the taxa of the complex, B. *alopecuroides* had shortest infloresecence (average 4.26 cm) and *B. major* var. *ovata* had the longest inflorescence (average 7.25 cm) (Character 17, Fig. 4). The inflorescence was simple, usually terminal, and consisted of a series of helicoid cymes (monochasia) arranged closely and compactly in dense spikes. Bracts were ovate to broadly elliptic with conspicuous mid-veins and cuspidate to acuminate apices. The shape of bract was one of the main characters used by Komarov (1936) for distinguishing some species of *Bistorta*. However, the shape and size of bracts was variable among the populations of a species in the taxa of *B. manshuriensis* complex and showed little taxonomic significance.

Flowers: Flowers bloom mostly from May to August. In *Bistorta*, the flowers are generally hermaphroditic with variable number of parts. Each flower is articulated at the base of the perianth with pedicel. Perianth is five-parted and nonaccrescent in fruit. The number of stamens is eight with flattened filament. The style is three-parted correlated with trigonous achene. The number of flower parts was found to be a constant character in the *B. manshuriensis* complex, with the number of tepals, stamens and styles five, eight and three respectively in all members. The color of the perianth was white, pink to purplish pink in the taxa of the complex. The color of the tepal is another important diagnostic character in *Bistorta* (Tzvelev, 1989). However, the color of the perianth was highly variable among the populations of a species and in some cases within the populations. Tepals were glabrous, obong, nerved, obtuse at the apex and slightly fused at the base. Tepals had the same trifid vasculature in all taxa of the complex consistent with Ronse Decraene and Akeroyd (1988). Stamens were exserted and arranged at the base of the perianth in two whorls, alternating with small glandular nectaries.

Filaments were glabrous, white and flattened. The anthers were pale purple to pink. Nectaries were pale reddish purple in color and the inner nectaries were fused with the filament bases. The styles were 3-cleft, connate at base and were strongly exserted from the perianth. The stigmas were minutely capitate in all members of the complex.

Achenes: In *Bistorta*, like all other genera of Polygonaceae, the fruits are achenes of basically trigonous shape. In the taxa of the *B. manshuriensis* complex, the trigonous achenes, with ovate or elliptic outline, were enclosed in the perianth or slightly exserted. The color of the achene was brown, dark brown to black. Stipe was absent but the beak was well developed. The achene surface was smooth and shiny with tessellated cell outline consistent with the previous results (Ronse Decrane et al., 2000). The anticlinal walls were collapsed and undulating (Fig. 7). The achenes of *B. major* var. *ovata* were approximately 3.6 x 2.2 mm and were largest in the complex (Table 5). The achenes of *B. pacifica* were slightly smaller with average size of 3.4 x 2 mm. Meanwhile, the average seed size of Korean and Russian individuals identified as *B. manshuriensis* were similar to the Korean individuals identified as *B. alopecuroides* (2.9 x 1.9 mm vs. 3 x 1.9 mm). The results indicated that seed size is a useful taxonomic character in distinguishing some taxa of the *B. manshuriensis* complex.

Leaf stomata and microstructure of epidermal cells: Stomatal density and size of the taxa of the complex are shown in Table 6. Stomata are generally distributed on abaxial leaf surface (Table 6; Fig. 8). Stomata were rare or absent on adaxial leaf surface (Table 6). Both anisocytic and anomocytic type of stomatal complex were found on the abaxial leaf surface in all taxa. However, anisocytic stomata were found in remarkably higher proportion. In the samples identified as *B. manshuriensis,* average stomatal density on abaxial surface ranged from 99.5 to 231.4 mm^{-2}. In *B. pacifica*, the average stomatal densisty on abaxial surface ranged from 82.2 to 447.7 mm^{-2}. In the samples identified as *B. alopecuroides, B. major* var. *ovata* and *B. major* var. *japonica* the average stomatal density on abaxial surface was 482.2, 199 and 23.6 mm^{-2} respectively (Table 6). Thus, stomatal density was variable among different taxa and populations. The density of stomata per 1 mm^{2} was highest in an accession identified as *B. alopecuroides* and lowest in *B. pacifica* (Table 6). The average size of stomata including guard cells on abaxial surface was 18.8–27.5 x 9.3–19.3 μm in the complex (Fig. 8). The average size of stomata on abaxial surface of *B. manshuriensis* was 19.6–25.2 x 12.2–19.3 μm. The average size was 20.2–27.5 x 10.69–14.6 μm in *B. pacifica* and 18.1–18.3 x 9.3–11.2 μm in the sample identified as *B. alopecuroides*. Meanwhile, the average size of the stomata was 22.4 x 14.6 μm in *B. major* var. *ovata,* and 24.4 x 12.6 μm in *B. major* var. *japonica* (Table 6, Fig. 8).

In the *B. manshuriensis* complex, the shape and size of adaxial epidermal cells was basically same. Stomatal size was consistently larger on the adaxial than on the abaxial surface of the leaf across the taxa. The adaxial epidermal cells were polygonal with straight anticlinal walls. The size of the adaxial epidermal cells was 22.6–40.8 x 12.1–21.44 μm. The surface was covered with epicuticular wax (Fig. 8). Notably, epicuticular wax on the adaxial leaf surface was slightly variable among the taxa and among the population of the same taxon.

The epicuticular wax of Russian and the Korean samples identified as *B. manshuriensis*, except the sample of Mt. Odae, was thick and dense (Fig. 8).

Epicuticular wax in the individuals of Mt. Odae was weakly developed. Meanwhile, epicuticular wax was weakly developed on abaxial surface in *B. major* var. *ovata* and *B. major* var. *japonica* (Fig. 8). The size of the abaxial epidermal cells with partially linearized and irregular anticlinal walls was 47.6–77.3 x 23.8–29.7 µm in the complex. The epicuticular wax of abaxial leaf surface in the sample identified as *B. manshuriensis* is well developed (Fig. 8) compared to the sample of *B. pacifica* and the sample identified as *B. alopecuroides*. However, the epicuticular wax on the abaxial leaf surface of the individuals of Mt. Odae populations was weakly developed. The epicuticular wax on abaxial leaf surface was poorly developed in *B. major* var. *ovata* but strongly developed in *B. major* var. *japonica*. Thus, on the basis of variation in epicuticular wax characteristics, the latter two taxa could be clealy distinguished (Fig. 8).

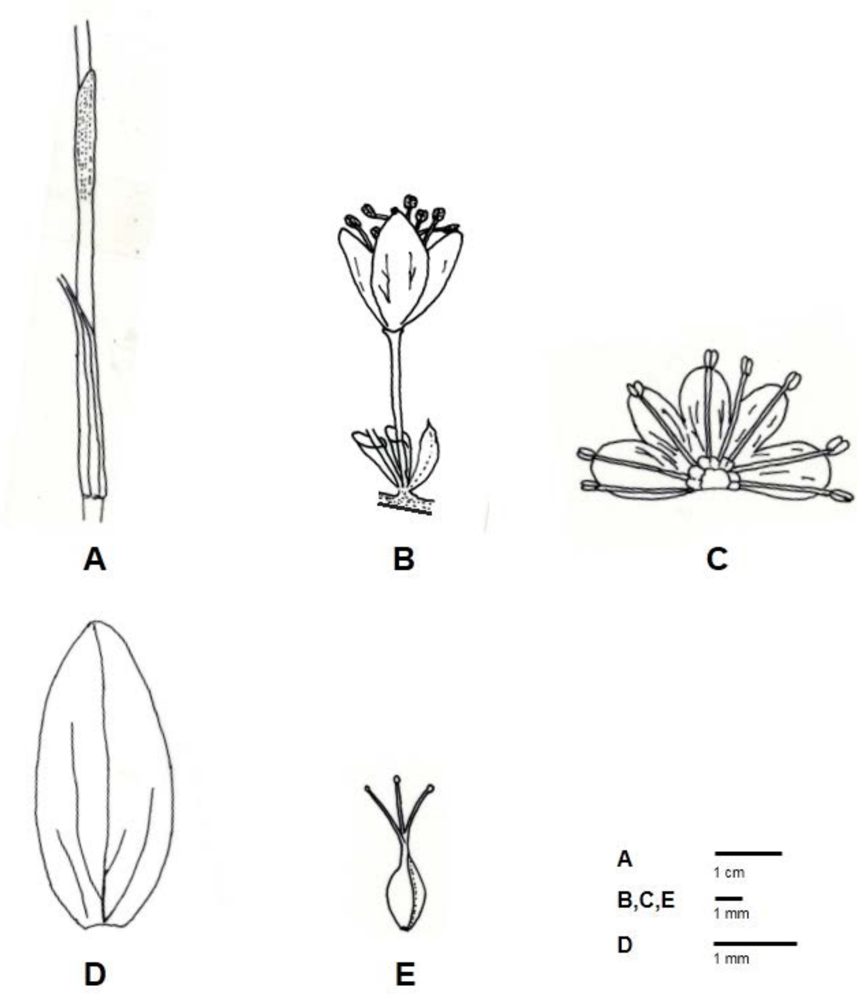

Fig. 4. Diagrams showing vegetative and reproductive parts in the *B. manshuriensis* complex. A. Leaf sheath and ochrea; B. A flower; C; A flower with tepals and stamens; D. A tepal; E. A pistil.

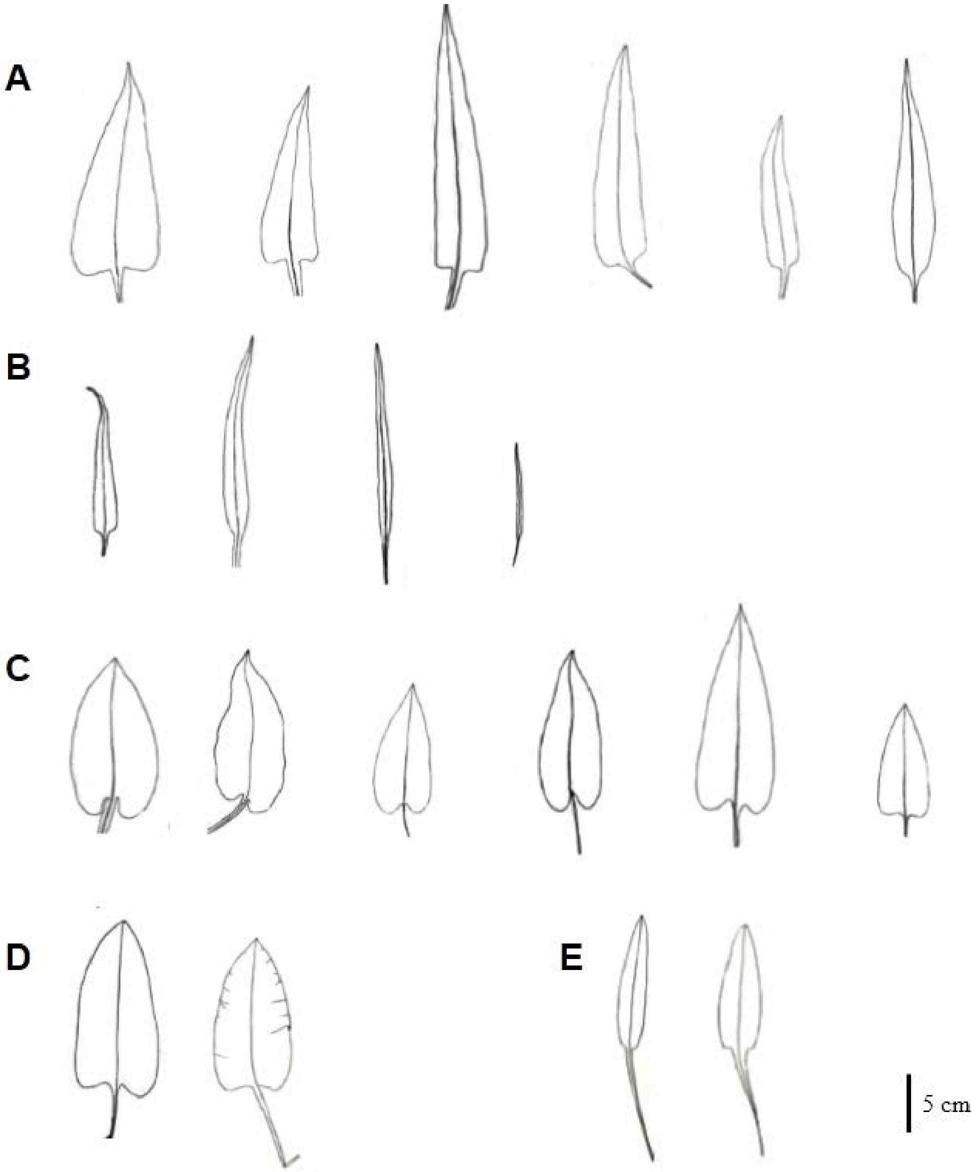

Fig. 5. Variation in leaf shape and size in the *B. manshuriensis* complex. A, Korean individuals identified as *B. manshuriensis;* B, Korean individuals identified as *B. alopecuroides*; C, *B. pacifica*; D, *B. major* var. *ovata*; E, *B. major* var. *japonica*.

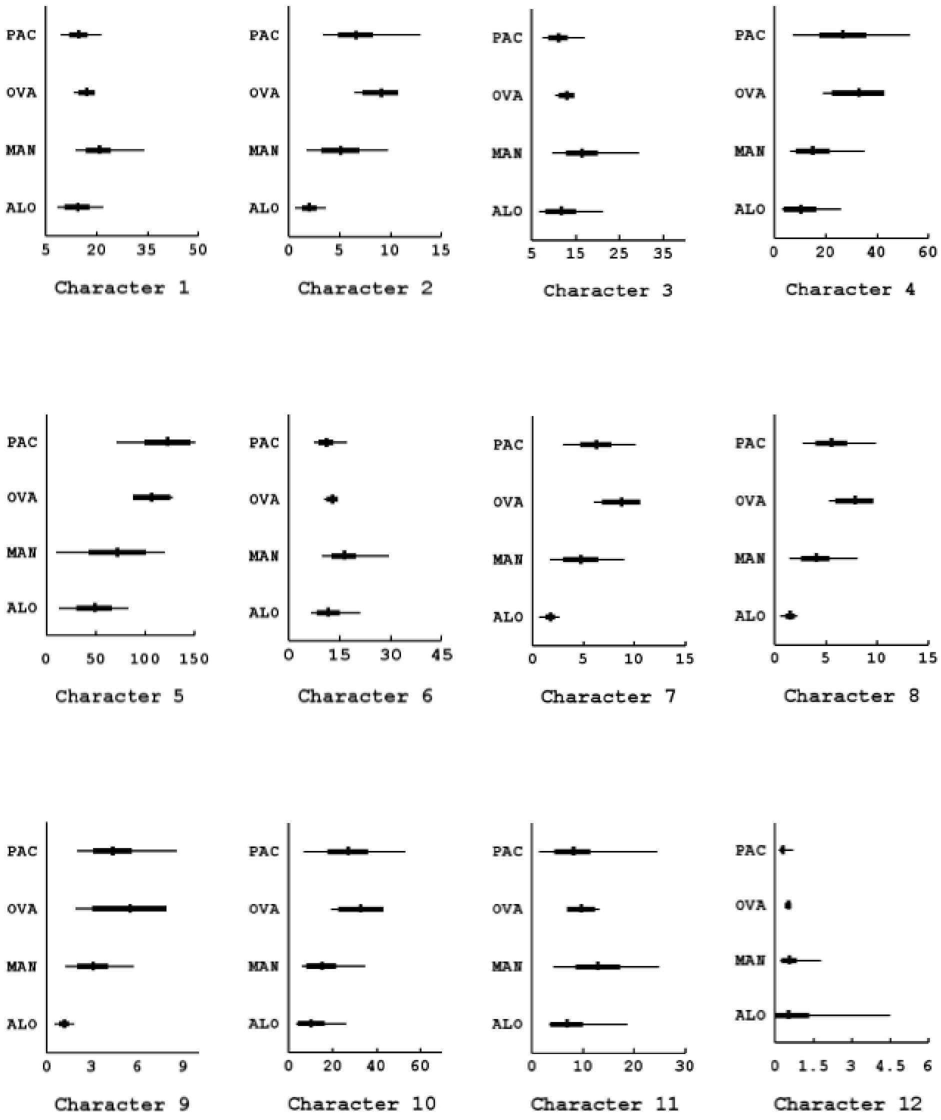

Fig. 6. Means, ranges and standard deviations of 17 morphological characters measured from individuals of the *B. manshureiensis* complex. Character numbers correspond to those in Table 1 and Fig. 1. PAC: *B. pacifica*, OVA: *B. major* var. *ovata*, MAN: *B. manshuriensis*, ALO: *B. alopecuroides.*

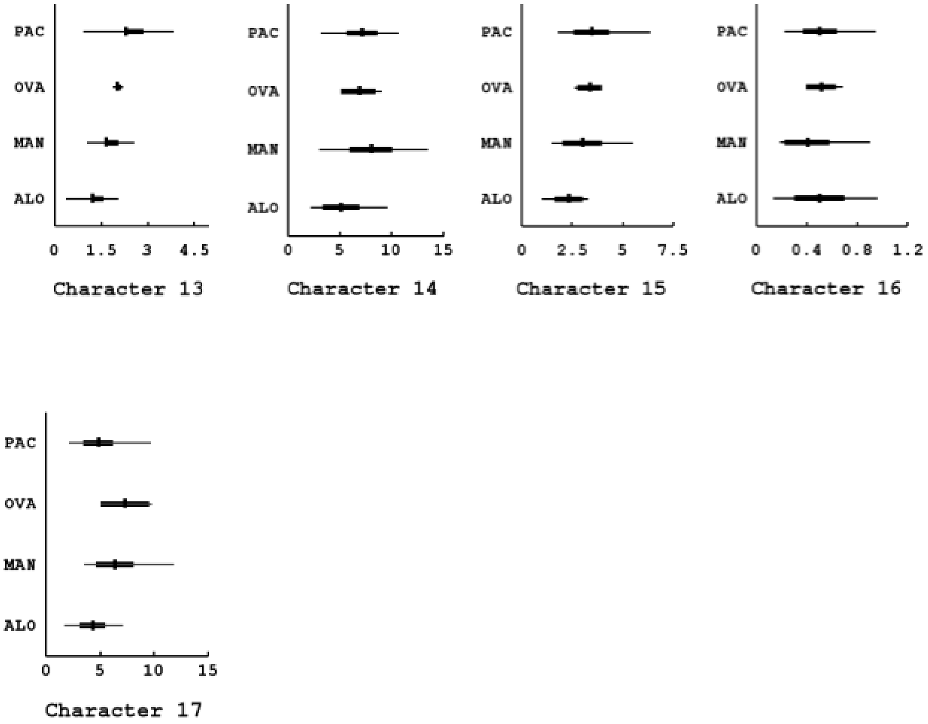

Fig. 6. (Continued)

Table 5. Size of achenes of the taxa of the *B. manshuriensis* complex.

Taxon	Length (mm)			Width (mm)			W/L
	Min.	Max.	Mean	Min.	Max.	Mean	
B. manshuriensis	2.4	3.4	2.9	1.5	2.6	1.9	0.66
B. pacifica	2.9	4	3.4	1.5	2.6	2	0.59
B. major var. *ovata*	3.2	3.9	3.6	1.9	2.5	2.2	0.61
B. alopecuroides	2.7	3.5	3	1.5	2.7	1.9	0.63

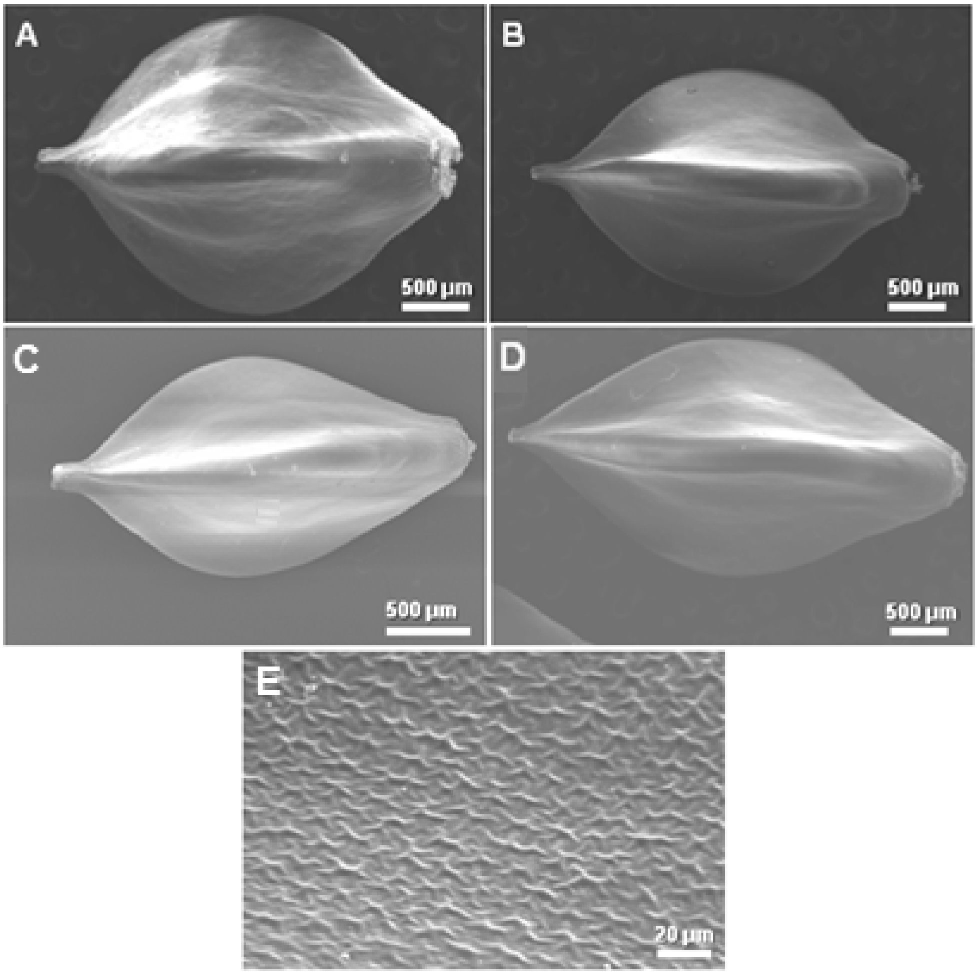

Fig. 7. Achenes and achene surface of the *Bistorta manshuriensis* complex. A. *B. manshuriensis*; B. *B. pacifica*; C., E. *B. alopecuroides*; D. *B. major* var. *ovata*; and E. Achene surface.

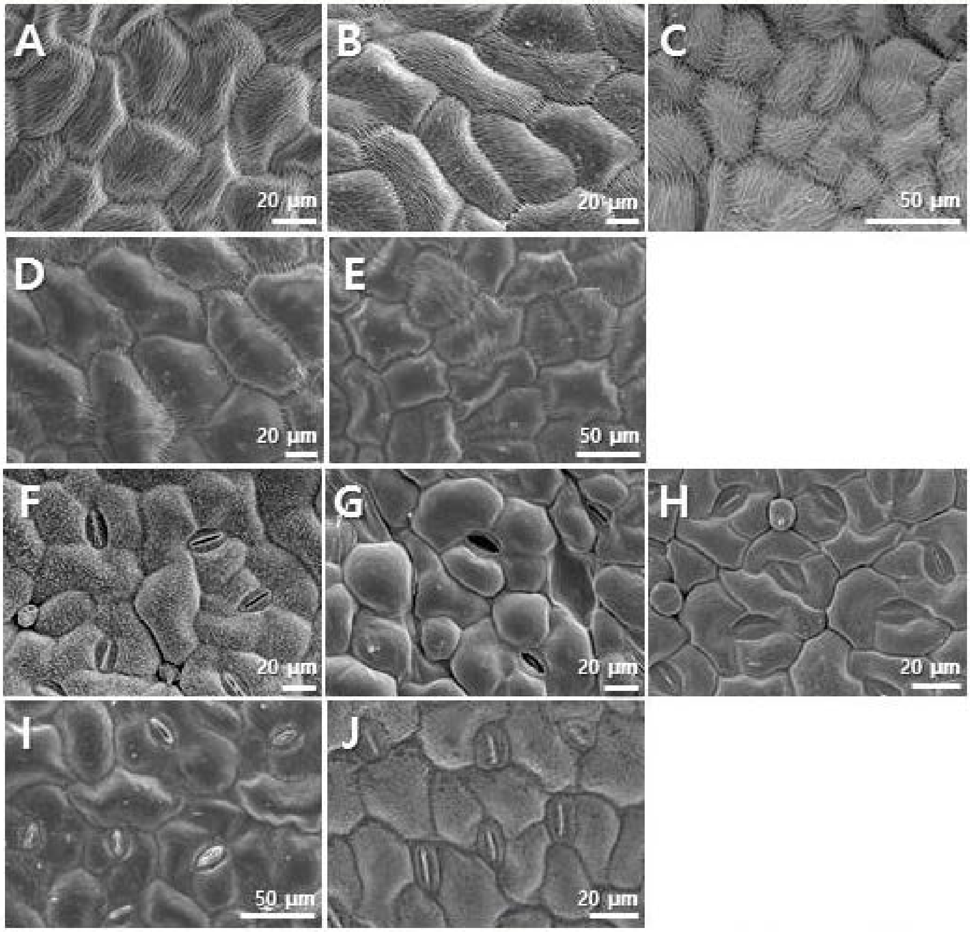

Fig. 8. SEM micrographs of adaxial (A–E) and abaxial (F–J) leaf surfaces of the *B. manshuriensis* complex and closely related taxa. A, F. Korean sample identified as *B. manshuriensis;* B, G. *B. pacifica*; C, H. Korean sample identified as *B. alopecuroides;* D, I. *B. major* var. *ovata;* E, J. *B. major* var. *japonica*.

Table 6. Stomatal characteristics on abaxial leaf surfaces of the *B. manshuriensis* complex and related species.

Taxa and accessions	**Stomatal complex**		**Size of stomata (μm)**	
	Type	**SP**[a]	**L: min (mean) max**	**W: min (mean)max**
B. alopecuroides				
kr_gr1	ano, ani	402.1	17.6–(18.3)–20.7	10–(11.2)–13.8
kr_hl16	ano, ani	562.3	15–(18.1)–19.9	6.8–(9.3)–12.1
B. manshuriensis				
kr_ jl3	ano, ani	231.4	18–(21)–23.8	9.3–(12.4)–14.6
kr_hg1	ano, ani	231.4	17.6–(18.5)–22.2	7.4–(11.5)–13.9
rs_kh15	ano, ani	129.8	15.8–(25.2)–29	12.6–(19.3)–16
kr_jm4	ano, ani	99.5	17.2–(19.6)–24.1	9.1–(12.2)–14.9
B. pacifica				
kr_sk1	ano, ani	447.7	15.8–(20.2)–24.8	10.5–(14.6)–2
kr_so7	ano, ani, act	142.7	21.9–(27.5)–29.3	11.27–(14.3)–17.9
rs_nk3	ani, ano	82.2	15.1–(20.6)–27.6	5.6–(10.7)–18.8
B. major* var. *ovata				
O_hk2	ani, ano	199	18–(22.4)–29.2	12.9–(14.6)–18.1
B. major* var. *japonica				
J_hn2	ano, ani, act	233.6	19–(24.4)–29.5	8.6–(12.6)–15.2

List of abbreviations –Type: Act, Actinocytic; Ano, anomocytic; Ani, anisocytic; SP, stomatal presence.

[a] number of stomata per 1 mm^2.

2. Principal components analysis of major morphological characters

The variances accounted for the axes I to III were 39.7, 22.1, and 9.2% respectively. The first two principal axes (I and II) accounted for 61.8% variance. The scatter plot of the specimens on axes I and II are shown in Fig. 9. The samples of *B. manshuriensis* collected from northeast China and some populations of Russian Far East could not be included in the analysis due to the absence of basal leaves in those specimens. The diagram using the first two axes illustrated the taxonomic relationship among the species. Three weakly separated clusters were formed corresponding to *B. pacifica* and *B. major* var. *ovata*, the Korean and Russian samples identified as *B. manshuriensis*, and the Korean samples identified as *B. alopecuroides*. Overlap between the taxa identified as *B. alopecuroides* and *B. manshuriensis*; and between *B. manshuriensis* and *B. pacifica* was evident in the diagram. Almost all of the characters used in this analysis made important contributions to axis 1 (Table 7). Leaf blade width at 1/3, 1/2 and 2/3 point of leaf blade, leaf blade width at the widest point and ratio between width and length of leaf blade were the first five most important characters of this axis (Table 7). The Korean samples identified as *B. alopecuroides* are concentrated on the left side of the diagram where OTUs with smaller and narrower leaves are located. However, the Korean samples identified as *B. alopecuroides* do not form a distinct group as some OTUs are mixed with OTUs of *B. manshuriensis*. Axis II separates *B. manshuriensis* from *B. pacifica*, although some OTUs belonging to one species are still mixed among those of the other. The first five most important characters contributing to axis II were leaf blade length, position of the maximum width in leaf blade, length of the petiole wing, inflorescence length, and ochrea length (Table 7). Due to higher value of PC2, Korean samples identified as *B. manshuriensis* are weakly separated from the cluster of *B. pacifica* and *B. major* var. *ovata*. Compared to *B. pacifica* and *B. major* var. *ovata, B. manshuriensis* has longer basal leaves and tendency of location of maximum leaf width towards the base which results in the predominant distribution of *B. pacifica* on the lower right side of the diagram. These characteristics are shared by four OTUs of *B. major var. ovata* which are thus mixed with the samples of *B. pacifica*. An OTU of *B. pacifica* from Russia was located at extreme right of this cluster. The taxa in the *B. manshuriensis* complex show considerable morphological diversity though the genetic variation was low. The morphological variation of the taxa within the species complex might be a reflection of the microhabitats in which the populations grow (low elevation: seacoast, wetland; high elevation: under the forest in mountain ridges, open area, grassland in mountain peaks). The result of the multivariate analysis supports the transfer of *B. major* var. *ovata* within the *B. pacifica* group.

The taxonomy of the *B. manshuriensis* species complex has been controversial and difficult to assess. The morphological diversity of key diagnostic characters both within a population or taxon and between taxa has led to disagreement among taxonomists about the circumscriptions of species and difficulty in creating usable field keys for the group. In the present study, no cluster was distinct in the PCA plot that corresponded to the currently recognized delimitations of the taxa within the *B. manshuriensis* species complex. It indicated that the diagnostic chacracters based on basal leaves are useful but not adequate to distinguish the three species of the complex, as a sharp separation among was not accomplished in the PCA analysis.

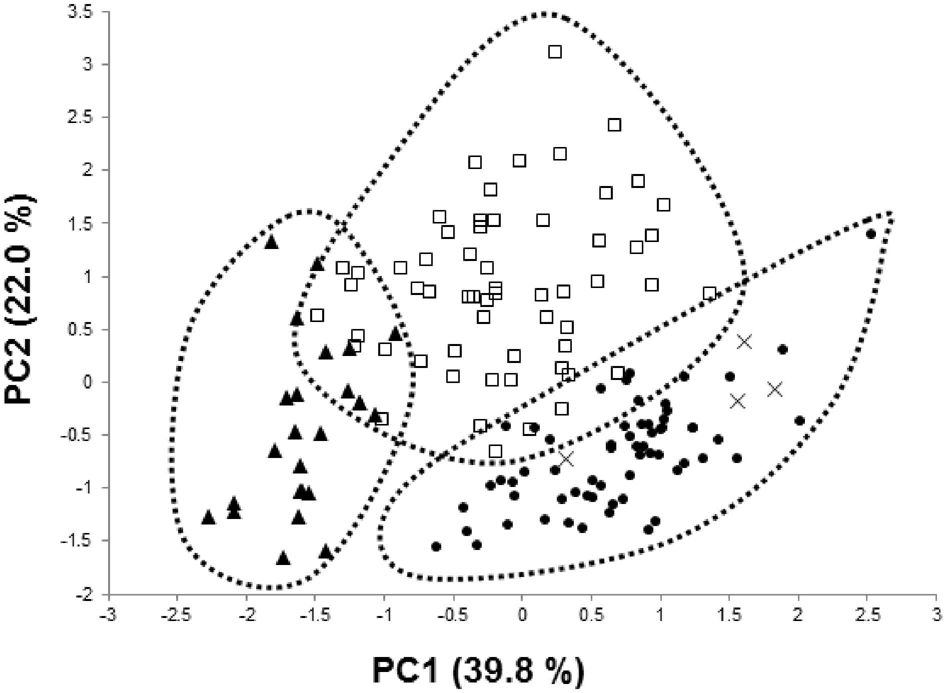

Fig. 9. Ordination of 150 individuals of the *B. manshuriensis* complex and related species along PC1 and PC2 from the principal component analysis using 17 morphological chatacters. Symbols: □ = Korean and Russian samples identified as *B. manshuriensis,* ▲= Korean samples identified as *B. alopecuroides,* ● = *B. pacifica,* ✕ = *B. major* var. *ovata.*

Table 7. Loadings of the first three principal components for 17 morphological characters from the analysis of 150 individuals of the *B. manshuriensis* complex and related taxa. Character numbers correspond to those in Table 1.

Character no.	**PC**		
	1	**2**	**3**
1	0.0543	**0.4749**	0.0539
2	**0.3571**	0.0406	0.0204
3	0.0357	**0.4719**	0.0157
4	0.2359	-0.1992	0.0363
5	0.2890	-0.1763	-0.1466
6	**0.3256**	-0.2026	-0.0508
7	**0.3662**	0.0313	0.0545
8	**0.3652**	0.0079	0.0691
9	**0.3590**	-0.0013	0.0510
10	0.2829	0.1842	-0.1525
11	0.1029	**0.3529**	**0.2157**
12	-0.0374	0.1892	**0.2749**
13	0.2459	-0.1703	-0.2200
14	0.1419	**0.2851**	-0.3974
15	0.2149	-0.0055	**0.3476**
16	0.0397	-0.2214	**0.6668**
17	0.0794	**0.2893**	**0.2088**
Eigenvalue	6.7568	3.74651	1.56239
Cumulative % of eigenvalues	**39.8**	**61.8**	**71.0**

3. Chromosome number

Analysis of mitotic metaphase spreads revealed that the samples of *B. manshuriensis* collected from China and Russia were diploids with 2*n* = 24. The Korean samples identified as *B. manshuriensis* were also diploids. The individuals of *B. pacifica* collected from China, Korea and Russia were tetraploids with 2*n* = 48. In addition, the Korean samples identified as *B. alopecuroides* were also diploids with 2*n* = 24. In contrast, the individuals of *B. alopecuroides* collected from Mongolia were tetraploids with 2*n* = 48. The present study represented the first reported chromosome counts for *B. manshuriensis* and *B. alopecuroides*. The individuals of *B. major* var. *ovata* as well as *B. major* var. *japonica* from Japan were tetraploids with 2*n* = 48 (Fig. 10, Table 8).

Bistorta pacifica was clearly distinguishable from *B. manshuriensis* and the individuals of Jeju island identified as *B. alopecuroides* on the basis of chromosome numbers. Despite extensive sampling, triploids (2*n* = 36) were not found in any of the individuals sampled in this study which suggested that the diploids and tetraploids of the complex are reproductively isolated. Meanwhile, *B. pacifica* and *B. major* var. *ovata* have similar morphology and identical chromosome number which supported the inclusion of the later taxon in *B. pacifica*. The individuals distributed in Mt. Seorak of Korea characterized with narrow leaf blade with subcordate leaf base and undulate leaf margin are closely related to *B. pacifica* on the basis of morphology. However, the plants of Mt. Seorak were cytologically different with diploid (2*n* = 24) chromosome number. Hence, the result indicated that the individuals of Mt. Seorak probably represent a new species.

The previous report of base chromosome number for the genus *Bistorta* is $x = 11$ and 12 (Löve & Löve, 1974; Karlsson, 2000; Freeman & Hinds, 2005). All species assigned to the *B. manshuriensis* complex and included in this study for chromosome counts consistently had the base number $x = 12$. Thus, chromosome base number was stable in the taxa of the *B. manshuriensis* complex, and was also consistent with one of the two base chromosome numbers reported previously for the genus *Bistorta*.

Table 8. Collection data and chromosome numbers for 53 populations of the *B. manshuriensis* complex and closely related taxa examined in this study.

Species	**Locality and voucher**	**Chromosome number (2*n*)**
B. manshuriensis		
	Russia. Primorsky, Khankisky, *Park et al. 59, 83*	24
	Russia. Primorsky, Russia Island, *Park & Choi 54*	24
	China. Jilin, *Park & Choi 27, 7*	24
	China. Heilongjiang, *Park & Choi 74*	24
Korean individuals identified as *B. manshuriensis*		
	Chungbuk, Mt. Seondo, *Bhandari 1052*	24
	Chungnam, Mt. Oseo, *Bhandari 803, 813*	24
	Chungnam, Manripo, *Bhandari 1105*	24
	Chungnam, Guraepo, *Bhandari 16719-6*	24
	Chungnam, Mt. Buchhun, *Bhandari 16711-13*	24
	Gyeongbuk, Mt. Biseul, *Bhandari 1002, 1010*	24
	Gyeongbuk, Gasansanseung, *Won 342, Bhandari 7742*	24
	Jeonnam, Mt. Mudeong, *Bhandari 8055*	24
	Jeonnam, Mt. Byeongfung, *Bhandari 7721, 7731*	24
	Jeonnam, Mt. Duryun, *Bhandari 7030*	24
	Gyeonggi, Mt. Gayeon, *Bhandari 8032*	24
	Gyeonggi, Namhansanseong, *Bhandari 16724-3; -2*	24
	Gyeonggi, Mt. Suwon, *Bhandari 16711*	24

Table 8. (Continued).

Species	**Locality and voucher**	**Chromosome number (2*n*)**
	Gangwon, Mt. Odae, *Bhandari 101, Suh 15628-6*	24
	Gangwon, Mt. Odae, Daegwanryeong, *Suh 1666*	24
	Gangwon, Mt. Odae, Jilmaenuf, *Bhandari, Suh01*	24
	Gangwon, Mt. Daerung, *Bhandari* 52	24
	Gyeongnam, Mt. Jagul, *Bhandari 7752*	24
	Gyeongnam, Mt. Bulmo, *Won 579*	24
	Gyeongnam, Mt. Jongnam, *Bhandari 635, 636*	24
B. pacifica		
	Russia. Primorsky, Shkotovsky, *Park et al. 13*	48
	Russia. Primorsky, Ussurisk, *Park & Choi 107, 108*	48
	China. Jilin, *Choi 003; Park & Choi 53*	48
	Korea. Chungbuk, Mt. Sobaek, *Bhandari 4*	48
	Korea. Chungbuk, Mt. Minjuji, *Bhandari 1515*	48
	Korea. Gangwon, Mt. Taebaek, *Bhandari 702*	48
	Korea. Gangwon, Mt. Gyebang, *Bhandari 12724-9*	48
	Korea. Gangwon, Mt. Gariwang, *Bhandari 153*	48
	Korea. Gangwon, Mt. Dae-am, *Suh et al. 823-6, 823-14, 1584-5*	48
	Korea. Gangwon, Mt. Hambaek, *Bhandari 7082*	48
	Korea. Gangwon, Geumdaebong, *Bhandari 7092*	48

Table 8. (Continued).

Species	**Locality and voucher**	**Chromosome number (2*n*)**
	Korea. Gangwon, Mt. Hambaek, Manhangje, *Suh 1575-7, Bhandari 16630-34*	48
	Korea. Mt. Cheongok, *Bhandari 16630-1*	48
	Korea. Gangwon, Mt. Seorak, *Bhandari621-1, 2007-5*	24
	Korea. Jeonbuk, Mt. Jiri, *Bhandari 502, 517, 518*	48
	Korea. Gyeonggi, Mt. Hwaak, *Bhandari 202, 208*	48
B. alopecuroides		
	Mongolia. *Park & Kim B9*	48
Korean individuals identified as *B. alopecuroides*		
	Gyeongnam, Mt. Gara, *Won 608*	24
	Jeju, Mt. Halla, *Won & Bhandari 313, Kim 14904-5*	24
	Jeju, Mt. Halla, Witseoreum, *Kim 14904-2*	24
B. major var. *ovata*		
	Japan. Hokkaido, Mt. Obira, *Kim 32*	48
B. major var. *japonica*		
	Japan. Honshu, Nikko, *Park et al. 198*	48

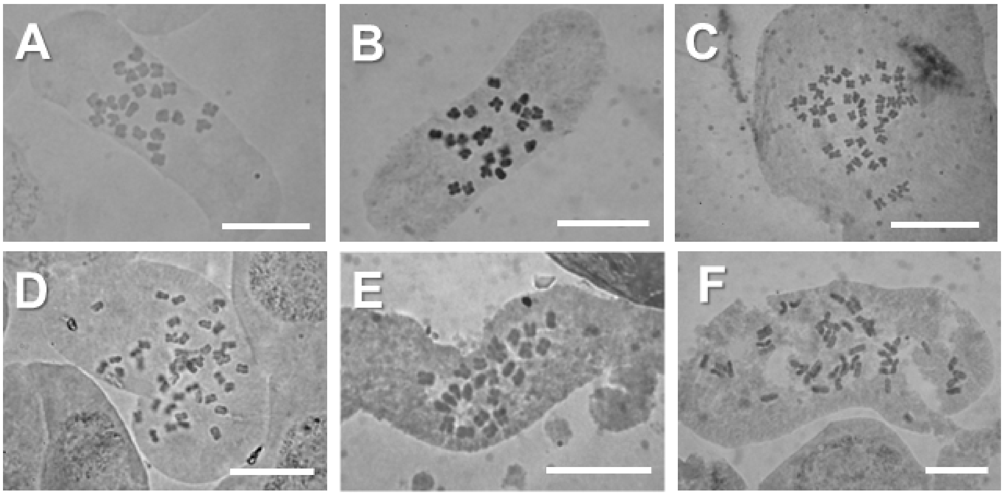

Fig. 10. Somatic chromosomes of the *B. manshuriensis* complex and closely related taxa. A. *B. manshuriensis* (2*n* = 24; *Park & Choi 27*); B. Korean sample identified as *B. manshuriensis* (2*n* = 24; *Bhandari 635*); C. *B. pacifica* (2*n* = 48; *Bhandari 4*); D. *B. major* var. *ovata* (2*n* = 48; *Kim 32*); E. Korean sample identified as *B. alopecuroides* (2*n* = 24; *Won & Bhandari 313*); F. *B. alopecuroides* (2*n* = 48; *Park & Kim 9*); See Table 8 for voucher information. Scale bars = 10 µm.

4. DNA sequencing

(1) Nuclear DNA

The sequence characteristics of ITS region are presented in Table 9. Total alignment of ITS1-5.8S-ITS2 was 593 bp in length. The length of ITS1, 5.8S rDNA and ITS2 was 196–197 bp, 164 bp and 232 bp respectively in all ingroup accessions. The GC content varied from 62.4–62.7% in ITS1 and 68.8–70.1% in ITS2. The percentage of GC content in the taxa of the complex was similar to that of other species of Polygonaceae (Yoo, 2000; Wan et al., 2014). The ITS sequence data revealed the presence of 28 ribotypes in the complex based on 23 variable sites. The distribution pattern of ribotypes in the populations of the *B. manshuriensis* complex and related taxa is presented in Table 11. Nine ribotypes (R1, R2, R4, R5, R7, R9, R10, R13 and R21) were shared by two or more taxa of the complex. Ribotype R1 was geographically widespread, and was distributed in nearly all individuals of all taxa of the complex. *Bistorta manshuriensis* and *B. pacifica* contained seven and 15 ribotypes respectively. Five ribotypes (R1, R2, R4, R5 and R7) were shared by *B. pacifica*, Korean populations identified as *B. manshuriensis*, and Korean populations identified as *B. alopecuroides*. *Bistorta pacifica* and *B. major* var. *ovata* shared five ribotypes in total. Twelve ribotypes were population-specific. In Korea, populations identified as *B. manshuriensis* and *B. alopecuroides* possessed seven and eight ribotypes in total respectively. Meanwhile, three populations identified as *B. manshuriensis* in Khanka region of Russia harbored five ribotypes. One to four ribotypes were found in each of the 39 individuals sampled in nine populations of *B. manshuriensis* from Russia and China. Two to four ribotypes were found in 12 individuals sampled from 10 populations in Korea identified as *B. manshuriensis*. Similarly, in *B. pacifica*, 19 accessions sampled from 16 populations were polymorphic. Two to six ribotypes were found in six individuals sampled from three Korean populations identified as *B. alopecuroides*. All Korean individuals of the *B. manshuriensis* complex as well as *B. major* var. *japonica*, *B. major* var. *ovata* and *B. alopecuroides* sampled in this study were polymorphic. Thus, ribotype polymorphism was prevalent in all taxa of the *B. manshuriensis* complex. In addition, the ribotypes of some individuals resolved in different clades, which suggested occurrence of gene flow among the taxa and populations of the complex.

The NJ tree inferred from 28 ribotypes is shown in Fig. 11. The tree resolved the *B. manshuriensis* complex as highly supported monophyletic group (PP = 1). The tree was largely unresolved and the individuals of the taxa were grouped in four major clades. However, the individuals of *B. manshuriensis*, *B. pacifica*, *B. alopecuroides* and *B. major* var. *ovata* did not form monophyletic groups.

(2) Chloroplast DNA

Initially, analysis of chloroplast DNA included six coding and non-coding regions: two protein coding genes (*matK* and *ndhF*), two introns (*trnK* and *rpl16*) and two intergenic spacers (*psbA*-*trnH* and *rbcL*-*accD*). The sequence characteristics of the examined cpDNA regions are presented in Table 12. A 30 bp inversion (hair-pin structure) was inferred in *psbA*-*trnH* IGS in two Russian populations of *B. manshuriensis* and three Korean populations identified as

Table 9. Sequence characteristics of nuclear rDNA ITS regions of the *B. manshuriensis* complex and closely related taxa.

	rDNA ITS			
	ITS 1	**5.8S**	**ITS 2**	Total
Amplified length (bp)				
Ingroup	196–197	164	232	592–593
Outgroup	196	164	230	590
Aligned length (bp)	197	164	232	593
Number of indels	1	0	2	3
Number of variable characters (outgroup excluded)	20 (11)	1 (1)	26 (11)	47 (23)
Number of parsimony informative characters (outgroup excluded)	14 (6)	1 (1)	16 (8)	31 (15)
G+C content (%)	62.4–62.7	55.5–56.1	68.8–70.1	62.9–63.6

Table 10. A summary of variable sites for ITS in the individuals of the *B. manshuriensis* complexdetected through direct sequencing and cloning.

Ribo-type	Variable nucleotide sites																					
	029	049	055	063	064	075	144	156	177	186	192	210	328	383	393	457	492	499	506	525	542	544
R1	C	C	G	C	G	G	C	A	G	C	-	G	C	C	T	C	A	T	T	C	C	A
R2	C	C	G	T	G	G	C	A	G	C	-	G	C	T	T	C	A	T	T	C	C	A
R3	C	C	G	T	G	G	C	A	G	C	-	G	C	T	T	T	A	T	T	C	C	A
R4	C	C	G	C	G	G	C	A	G	C	-	G	C	T	T	C	A	T	T	C	C	A
R5	C	C	G	T	G	G	C	A	G	C	-	G	C	C	T	C	A	T	T	C	C	A
R6	C	C	G	C	G	G	C	G	G	C	-	G	C	C	T	C	A	T	T	C	C	A
R7	C	C	G	C	G	G	C	A	G	C	-	G	C	C	A	C	A	T	T	C	C	A
R8	C	C	G	C	G	G	C	A	G	C	-	G	A	T	T	C	A	T	T	C	C	A
R9	C	C	G	C	G	G	C	A	G	C	-	G	C	C	T	C	A	T	T	T	C	A
R10	C	C	G	T	G	G	C	A	G	C	C	G	C	C	T	C	A	T	T	T	C	A
R11	C	C	G	T	G	G	C	A	G	C	-	G	C	C	T	C	A	T	G	C	C	A
R12	C	C	G	C	G	G	C	A	G	C	-	G	C	C	T	C	A	T	G	C	C	A
R13	C	C	G	C	G	G	C	A	G	C	-	G	C	C	T	C	A	T	G	C	C	A
R14	T	C	G	C	G	G	C	A	G	C	-	G	C	C	T	C	A	T	G	C	C	A
R15	C	C	G	A	G	G	C	A	G	C	-	G	C	C	T	C	A	T	T	C	C	A
R16	C	C	G	C	G	G	C	A	A	C	-	G	C	C	T	C	A	A	T	C	C	A
R17	C	C	G	T	G	G	C	A	G	C	-	G	C	C	T	C	G	T	T	C	C	A
R18	C	C	C	C	G	G	C	A	G	C	-	G	C	C	T	C	A	T	T	C	C	A
R19	C	C	G	C	G	G	G	A	G	C	-	G	C	C	T	C	A	T	T	C	C	A
R20	C	C	G	C	G	G	C	A	G	C	-	G	C	C	T	C	G	T	T	C	C	A
R21	C	C	G	C	A	G	T	A	G	C	-	G	C	C	A	C	A	T	T	C	C	A
R22	C	C	G	C	G	G	C	A	G	C	-	G	C	C	T	C	A	T	T	C	A	A
R23	C	C	G	C	A	G	C	A	G	C	-	G	C	C	T	C	A	T	T	C	C	A
R24	C	C	G	C	G	G	C	A	G	T	-	G	C	C	T	C	A	T	T	C	C	A
R25	C	C	G	C	G	G	C	A	G	C	-	A	C	C	T	C	A	T	T	C	C	A
R26	C	C	G	C	G	A	C	A	G	C	-	G	C	C	T	C	A	T	T	C	C	A
R27	C	T	G	C	G	G	C	A	G	C	-	G	C	C	T	C	A	T	T	C	C	A
R28	C	C	G	C	G	G	C	A	G	C	-	G	C	C	T	C	A	T	T	C	C	G

Table 11. Ribotype distribution in the populations of the *B. manshuriensis* complex and related taxa. Population code correspond to the codes in Table 2.

Population	Taxon/Accessions	Ribotypes																											
		01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
	B. manshuriensis																												
M1, 2	rs_kb1, rs_kh1, 2	●																											
M2	rs_kh3	●						●		●																●			
M3	rs_kh4, 9–11, 12–19, 22–24, 27, 29, 30	●																											
M3	rs_kh31	●								●																●			
M3	rs_kh8, 20, 25, 28	●						●																					
M4	rs_kh32	●																										●	
M5	rs_ot1	●																											
M6	rs_is2	●																											●
M8	cn_hj4	●																									●		
M8, 11, 12	cn_hj2, cn_ul1, cn_sb1	●																											
	Korean individuals identified as *B. manshuriensis*																												
M14	kr_jm1		●		●																								
M18	kr_hg1	●			●																								
M20	kr_nh1	●	●		●	●																							
M21	kr_gu1	●			●			●														●							
M22, 25	kr_mp1, kr_os1	●						●																					
M28	kr_bs1	●			●	●																							
M30, 32	kr_bu1, kr_mt1	●				●																							

Table 11. (Continued).

Population	Taxon/Accessions	Ribotypes																											
		01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
M33	kr_md2	●																							●				
M34	kr_dn2	●				●																							
M35	kr_sm2	●				●		●																					
	B. pacifica																												
P1	rs_ms1	●				●							●																
P1	rs_ms3	●	●								●	●	●	●															
P2	rs_nk1, 2	●																											
P4	rs_pr3	●																	●										
P5	rs_rc1	●			●					●							●			●									
P6	rs_rc7	●																											
P7	rs_us2	●				●						●		●		●													
P10	cn_jl1	●								●																			
P11	cn_jl3	●	●																										
P12	cn_sn2	●	●							●								●											
P13	cn_mc1	●				●															●								
P13	cn_mc2	●	●		●																●								
P14, 15	kr_hw1, kr_dm1	●	●	●																									
P16	kr_sk2		●	●			●																						
P16	kr_sk5		●	●																									
P17	kr_sh1	●	●		●	●	●		●																				
P19	kr_gw1	●	●	●	●																								
P19	kr_gw2	●	●	●																									
P20	kr_ck2	●	●	●	●	●																							
P21	kr_hc1	●	●		●	●		●																					

Table 11. (Continued).

Population	Taxon/Accessions	Ribotypes																											
		01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
P24	kr_mh1	●	●			●		●																					
P25	kr_tb1	●	●	●																									
P28	kr_il1	●	●		●	●	●																						
P29, 30	kr_mj1, kr_dk1	●	●		●	●																							
P31	kr_jr1	●	●		●																								
	B. major var. *ovata*																												
O1	jp_rb1	●				●					●	●			●														
O2	jp_hk2	●										●		●	●														
	B. alopecuroides																												
A7, 8	mn1, mn2	●												●															
	Korean individuals identified as *B. alopecuroides*																												
A1	kr_gr1	●																					●						
A2	kr_hl3	●				●																							
A2	kr_hl4	●						●																					
A5	kr_hl10	●	●		●	●																●		●					
A5	kr_hl11, 13	●						●																					

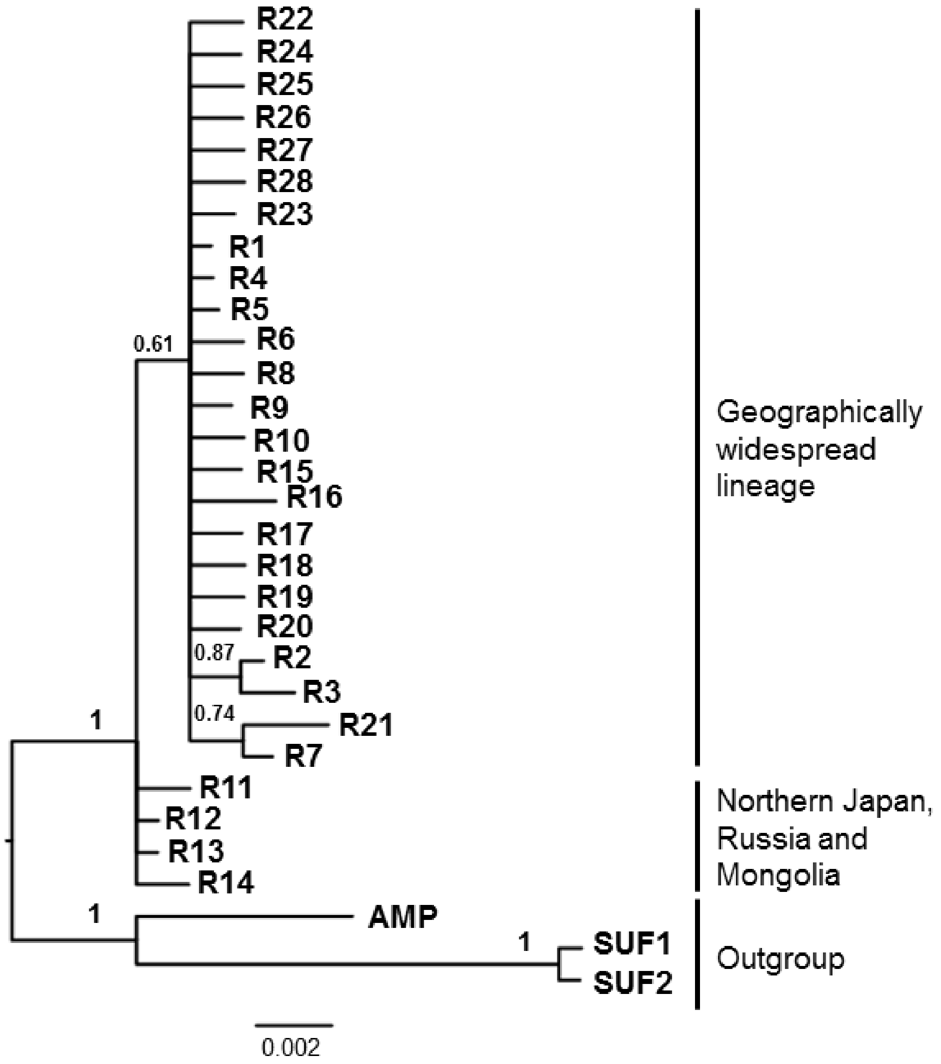

Fig. 11. The Neighbor-Joining tree showing phylogenetic relationship of ITS ribotypes. Names at the tips of branches indicate the ribotypes and outgroup taxa. Numbers above branches indicate posterior probabilities.

B. alopecuroides (Fig. 12). Mapping inverted and non-inverted sequence variants on *psbA-trnH* tree showed that the inversion probably occurred independently several times. Thus, the *B. manshuriensis* complex provided additional example of homoplasious nature of small inversions in non-coding chloroplast DNA (Whitlock et al. 2010). The combined cpDNA data set included 5785 base positions. The *rbcL-accD* IGS sequences contained the lowest percent (1.1%) and the *psb*A-*trn*H IGS sequences contained the highest percent (6.2%) of parsimony informative characters when outgroup taxa were excluded. The pairwise sequence divergences between ingroup taxa calculated using uncorrected P-distance method ranged from 0 to 0.004%. The number of variable sites in ingroup taxa was 109 (1.2%), including 70 parsimony informative characters. Preliminary analyses based on different combinations of the six cpDNA regions indicated that the IGS regions (*psbA-trnH* and *rbcL-accD*) and *rpl16* intron were not useful in resolving relationship and were prone to homoplasy due to higher rate of sequence evolution (as shown by large number of indels in alignment). Hence, these three regions were excluded from further analyses. Because there is no recombination within the cpDNA molecule, the three cpDNA regions were combined. The aligned data matrix for the combined analysis of cpDNA (*trnK* + *matK* + *ndhF*) consisted of 3803 bp for outgroup and ingroup accessions. No insertions and deletions were found in ingroup alignment except a single 1-bp indel in *trnK* region (Tabel 13).

(3) Distribution of cpDNA haplotypes

Based on the analysis of sixty six nucleotide substitutions and one 1-bp indel in the combined sequence alignment of three cpDNA regions, 43 haplotypes

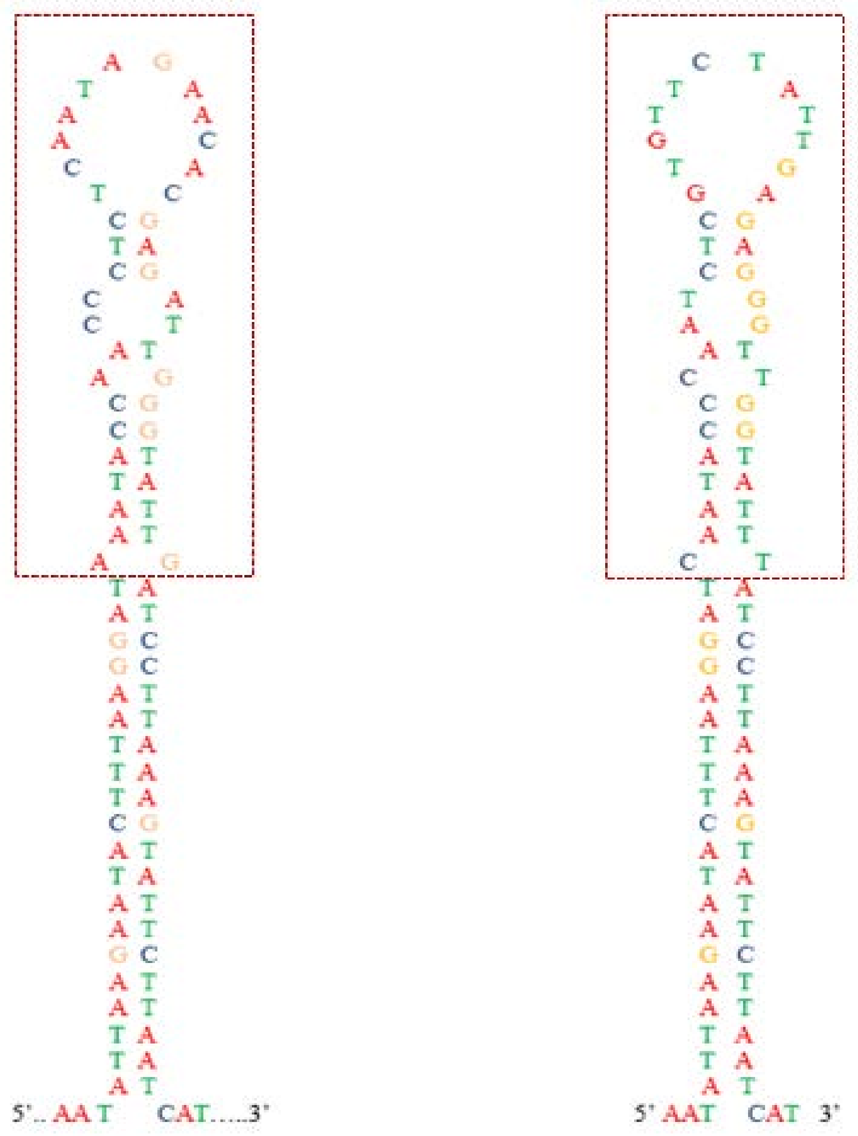

Fig. 12. Predicted secondary structures of the *psbA*-*trnH* IGS region of the *B. manshuriensis* complex and related taxa.   Boxes with broken line indicate the inverted region. Inversion begins from base number 98 to 178 in the aligned sequence data of *psbA*-*trnH* IGS.

Table 12. Sequence characteristics of *trnK* intron, *matK* gene, *psbA-trnH* IGS, *rpl16* intron *ndhF* gene and *rbcL-accD* IGS regions and combined dataset in the *B. manshuriensis* complex and related taxa.

		cpDNA regions						
		trnK	***matK***	***psbA-trnH***	***rpl16***	***ndhF***	***rbcL-accD***	**Combined**
Amplified length (bp)	**ingroup**	675–676	1133	319–425	868–915	1993	493–531	5482–5594
	outgroup	667–676	1133	294	877–889	1993	501–502	5475–5477
Aligned length (bp)		677	1133	486	952	1993	544	5785
No. of characters excluded		0	0	153	0	0	0	153
No. of variable characters (outgroup excluded)		22 (11)	40 (19)	26 (15)	26 (17)	73 (37)	17 (10)	204 (109)
No. of parsimony informative characters (outgroup excluded)		12 (5)	26 (13)	20 (11)	19 (11)	53 (24)	12 (6)	142 (70)
% informative characters (outgroup excluded)		1.8 (0.7)	6.2 (1.1)	4.1 (3.4)	2 (1.2)	2.7 (1.2)	2.2 (1.1)	2.5 (1.2)
Pairwise sequence divergence between all haplotypes of ingroup (%)		0–0.007	0–0.005	0–0.02	0–0.011	0–0.005	0–0.006	0–0.004
GC content (%) (ingroup only)		33.3–33.8	32.3–32.6	20.1–26.1	31.8–32.9	33.7–33.9	34.1–35.1	32.3–33

Table 13. Variable nucleotide sites in *trnK*, *matK* and *ndhF regions*.

Haplotype	*trnK*											*matK*																			
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	1	1	1	2	2	2	3	3	4	5	6	8	8	8	8	9	9	0	0	0	1	1	2	2	2	3	3	4	5	6	6
	2	3	5	5	5	8	2	6	2	7	1	1	2	2	3	5	8	1	4	4	1	3	1	2	9	4	7	2	5	0	2
	9	0	0	7	9	2	6	5	2	4	6	4	0	8	8	1	6	8	8	9	8	3	7	2	0	4	1	3	5	1	9
1	C	A	T	A	G	A	T	G	C	T	-	C	C	A	A	C	T	G	T	A	A	T	A	G	C	T	A	T	T	T	A
2	C	A	T	A	G	A	T	G	C	T	-	C	C	A	A	C	T	G	T	A	A	T	C	G	C	T	A	T	T	T	C
3	C	A	T	A	G	A	T	G	C	T	-	C	C	A	A	C	T	G	T	A	A	T	A	G	C	T	A	T	T	T	A
4	C	A	T	A	G	A	T	G	C	T	-	C	C	A	A	C	T	G	T	A	A	T	A	G	C	T	A	T	T	T	A
5	C	A	T	A	G	A	T	G	C	T	-	C	C	A	A	C	T	G	T	A	A	T	A	G	C	T	A	T	C	T	A
6	C	A	T	A	G	A	T	G	C	T	-	C	C	A	A	C	T	G	T	A	A	T	C	G	C	T	A	T	T	T	A
7	C	A	T	A	G	A	T	G	C	T	-	C	C	A	A	C	T	G	T	A	A	T	A	G	C	T	A	T	T	T	A
8	C	A	T	A	G	A	T	G	C	T	-	C	C	A	A	C	T	G	T	A	A	T	A	G	C	T	A	T	T	T	A
9	A	A	T	A	T	A	G	G	C	T	-	C	C	A	A	C	T	G	G	A	A	T	A	G	C	T	A	T	T	T	A
10	C	A	C	A	G	A	T	G	C	T	-	C	C	A	A	C	T	G	T	A	A	T	A	G	C	T	A	T	T	T	A
11	C	A	T	A	G	A	T	G	C	T	-	C	C	A	A	C	T	G	T	A	A	T	A	G	C	T	A	T	T	T	A
12	C	A	T	A	G	A	T	G	C	C	-	C	C	A	A	C	T	G	T	A	A	T	A	G	C	T	A	T	T	T	A
13	C	A	T	A	G	A	T	T	C	T	-	C	C	A	A	C	T	G	T	A	A	T	A	G	C	T	A	T	T	T	A
14	C	A	T	A	G	A	T	G	C	T	-	C	C	A	A	C	T	G	T	A	A	T	C	G	C	T	A	T	T	T	A
15	C	A	T	A	G	A	T	G	C	T	-	C	C	A	A	C	T	G	T	A	A	T	C	G	C	T	A	T	T	T	A
16	C	A	T	A	G	A	T	G	C	T	-	C	C	A	G	C	T	G	T	A	A	T	A	G	C	T	A	T	T	T	A
17	C	A	T	A	G	A	T	G	C	T	A	C	C	A	A	C	T	G	T	A	A	T	A	G	C	T	A	T	T	T	A
18	C	A	T	A	G	A	T	G	C	T	-	C	C	A	A	C	T	A	T	A	A	T	A	G	C	T	A	T	T	A	A
19	C	A	T	A	G	A	T	G	C	T	-	C	C	A	A	C	T	G	T	A	A	T	A	G	C	T	A	T	T	T	A
20	C	A	T	A	G	A	T	G	C	T	-	C	C	A	A	C	T	G	T	A	A	T	A	G	C	T	A	T	T	T	A
21	C	A	T	A	G	A	T	G	C	T	-	C	C	A	A	C	T	G	T	A	A	T	A	G	C	T	A	T	T	T	A
22	C	A	T	A	G	A	T	G	C	T	-	C	C	A	A	C	T	G	T	A	A	T	A	G	C	T	A	T	T	T	A
23	C	A	T	A	G	A	T	G	C	T	-	C	C	A	G	C	T	G	T	A	A	T	A	G	C	T	A	T	T	T	A
24	A	A	T	A	T	A	G	G	C	T	-	C	C	A	G	C	T	G	T	A	A	T	A	G	C	T	A	T	T	T	A
25	A	A	T	A	T	A	G	G	C	T	-	C	C	A	G	C	T	G	T	A	A	T	A	G	C	T	A	T	T	T	A
26	A	A	T	A	T	A	G	G	C	T	-	C	C	A	A	C	T	G	T	A	A	T	A	G	C	T	A	T	T	T	A
27	A	A	T	A	T	A	G	G	C	T	-	C	C	A	A	C	T	G	T	A	A	T	A	G	C	T	A	T	T	T	A
28	A	A	T	A	T	A	G	G	C	T	-	C	C	A	A	C	T	G	T	A	A	T	A	A	C	T	A	T	T	T	A
29	A	A	T	A	T	A	G	G	C	T	-	C	C	A	A	C	T	G	T	A	A	T	A	G	C	T	A	T	T	T	A
30	A	A	T	A	T	A	G	G	C	T	-	C	C	A	A	C	T	G	T	A	A	T	A	G	C	G	A	T	T	T	A
31	A	A	T	A	T	A	G	G	C	T	-	C	C	A	A	C	T	G	T	A	A	T	A	G	C	G	A	T	T	T	A
32	A	C	T	A	T	A	T	G	C	T	-	C	C	A	A	C	T	G	T	C	A	T	A	G	C	T	A	G	T	T	A
33	A	C	T	A	T	A	T	G	C	T	-	C	C	A	A	C	T	G	T	C	A	T	A	G	C	T	A	G	T	T	A
34	C	C	T	A	T	A	T	G	C	T	-	C	C	A	A	C	T	G	T	C	A	T	A	G	C	T	A	T	T	T	A
35	C	C	T	A	T	A	T	G	C	T	-	C	C	A	A	C	T	G	T	C	A	T	A	G	A	T	A	T	T	T	A
36	A	C	T	A	T	A	T	G	C	T	-	C	C	A	A	C	T	G	T	C	C	T	A	G	C	T	A	T	T	T	A
37	A	C	T	A	T	A	T	G	C	T	-	C	C	A	A	C	T	G	T	C	A	T	A	G	C	T	A	T	T	T	A
38	A	C	T	C	T	A	T	G	C	T	-	C	C	A	A	C	T	G	T	C	A	T	A	G	C	T	A	T	T	T	A
39	A	C	T	A	T	A	T	G	C	T	-	C	C	A	A	C	T	G	T	C	A	T	A	G	C	T	C	T	T	T	A
40	A	C	T	A	T	A	T	G	A	T	-	C	C	A	A	A	T	G	T	C	A	T	A	G	C	T	A	T	T	T	A
41	A	C	T	A	T	A	T	G	C	T	-	C	A	G	A	C	T	G	T	C	A	T	A	G	C	T	A	T	T	T	A
42	A	C	T	A	T	C	T	G	C	T	-	C	C	A	A	C	T	G	T	C	A	G	A	G	C	T	A	T	T	T	A
43	A	C	T	A	T	C	T	G	C	T	-	T	C	A	A	C	C	G	T	C	A	G	A	G	C	T	A	T	T	T	A

Table 13. (Continued).

Haplotype	*ndhF*																																			
	1964	2017	2037	2363	2383	2386	2398	2410	2435	2443	2491	2599	2633	2653	2844	3063	3106	3216	3250	3253	3285	3318	3352	3371	3389	3492	3510	3553	3598	3607	3664	3672	3698	3728	3759	3784
1	T	T	T	C	C	T	G	C	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	G	T	G	A	A	C	A	C	A	G
2	T	T	T	C	C	T	G	C	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	G	T	G	A	A	C	A	C	A	G
3	T	T	T	C	C	T	G	C	G	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	G	T	G	A	A	C	A	C	A	G
4	T	T	T	C	C	T	G	C	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	G	T	G	A	A	C	C	C	A	G
5	T	T	T	C	C	T	G	C	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	G	T	G	A	A	C	A	C	A	G
6	T	T	T	C	C	T	G	C	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	G	T	G	A	A	C	A	C	A	G
7	T	T	T	C	C	T	G	C	A	A	A	G	T	A	T	C	G	A	T	C	T	A	T	A	G	A	G	T	G	A	A	C	A	C	A	G
8	T	T	T	C	C	T	G	C	A	A	A	G	T	A	T	C	G	A	T	C	T	A	T	A	G	A	G	T	A	A	A	C	A	C	A	G
9	T	T	C	C	C	T	G	A	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	G	T	G	T	A	C	A	C	A	G
10	T	T	T	C	C	T	G	C	A	A	A	G	T	C	T	C	G	A	T	C	T	A	T	A	G	A	G	T	G	A	A	C	A	C	A	G
11	T	T	T	C	C	T	T	C	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	G	T	G	A	A	C	A	C	A	G
12	T	T	T	C	C	T	T	C	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	G	T	G	A	A	C	A	C	A	G
13	T	T	T	C	C	T	T	C	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	G	T	G	A	A	C	A	C	A	G
14	T	T	T	C	C	T	G	C	A	T	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	G	T	G	A	A	C	A	C	A	G
15	T	T	T	C	C	T	G	C	A	A	A	G	T	A	C	C	A	A	T	C	T	A	T	A	G	A	G	T	G	A	A	C	A	C	A	G
16	T	T	T	C	C	T	G	C	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	G	G	A	G	T	G	A	A	C	A	C	A	G
17	T	T	T	C	C	T	G	C	A	A	A	G	T	A	C	C	G	A	T	C	A	A	T	A	G	A	G	T	G	A	A	C	A	C	A	G
18	T	T	T	C	A	T	G	C	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	G	T	G	A	A	C	A	C	A	G
19	T	T	T	C	C	T	G	C	A	A	A	G	T	A	C	C	G	A	T	G	T	A	T	A	G	A	G	T	G	A	A	C	A	C	A	G
20	G	T	T	A	C	T	G	C	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	G	T	G	A	A	C	A	C	A	G
21	T	T	T	C	C	T	G	C	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	G	C	G	A	A	C	A	C	A	G
22	T	T	T	C	C	T	G	C	A	A	A	G	T	A	C	C	G	A	T	C	T	T	T	A	G	A	G	C	G	A	A	C	A	C	A	G
23	T	T	T	C	C	T	G	C	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	G	T	G	A	A	C	A	C	A	A
24	T	T	T	C	C	T	G	C	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	G	T	G	A	A	C	A	C	A	A
25	T	T	T	C	C	T	G	C	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	G	T	G	A	A	C	A	C	A	G
26	T	T	C	C	C	T	G	A	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	G	T	G	A	A	C	A	C	A	G
27	T	C	C	C	C	T	G	A	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	G	T	G	A	A	C	A	C	A	G
28	T	T	C	C	C	T	G	A	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	G	T	G	A	A	C	A	A	A	G
29	T	T	C	C	C	T	G	A	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	G	T	G	A	A	C	A	A	A	G
30	T	T	C	C	C	T	G	A	A	A	A	T	T	A	C	C	G	A	T	C	T	A	T	A	G	A	G	T	G	A	A	C	A	A	G	G
31	T	T	C	C	C	T	G	A	A	A	A	T	T	A	C	C	G	T	T	C	T	A	T	A	G	A	G	T	G	A	A	C	A	C	G	G
32	T	T	C	C	C	T	G	A	A	A	C	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	G	T	G	A	A	C	A	C	A	G
33	T	T	C	C	C	T	G	A	A	A	C	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	T	T	G	A	A	C	A	C	A	G
34	T	T	C	C	C	T	G	A	A	A	C	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	T	T	G	A	A	C	A	C	A	G
35	T	T	C	C	C	C	G	A	A	A	C	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	T	T	G	A	A	C	A	C	A	G
36	T	T	C	C	C	T	G	A	A	A	A	G	T	A	C	C	G	A	A	C	T	A	T	A	G	A	T	T	G	A	A	C	A	C	A	G
37	T	T	C	C	C	T	G	A	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	T	T	G	A	A	C	A	C	A	G
38	T	T	C	C	C	T	G	A	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	T	T	G	A	C	C	A	C	A	G
39	T	T	C	C	C	T	G	A	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	T	T	G	C	C	C	A	C	A	G
40	T	T	C	C	C	T	G	A	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	A	A	T	T	G	A	A	C	A	C	A	G
41	T	T	C	C	C	T	G	A	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	C	T	T	G	A	A	C	A	C	A	G
42	T	T	C	C	C	T	G	A	A	A	A	G	A	A	C	T	G	A	T	C	T	A	G	A	G	A	T	T	G	A	A	A	A	C	A	G
43	T	T	C	C	C	T	G	A	A	A	A	G	A	A	C	T	G	A	T	C	T	A	G	A	G	A	T	T	G	A	A	A	A	C	A	G

were identified from 182 accessions of ingroup taxa. The geographical distribution of all forty three cpDNA haplotypes is shown in Fig. 13. The distribution pattern of these haplotypes in the populations and taxa of the *B. manshuriensis* complex is given in Table 14. In *B. manshuriensis* sampled from northeast China and Russian Far East, 12 different haplotypes were detected in 47 individuals. Forteen haplotypes were detected in 38 Korean individuals identified as *B. manshuriensis*. Similarly, thirteen haplotypes were detected in 69 individuals of *B. pacifica*. In addition, nine different haplotypes were found in 16 individuals of Mt. Halla identified as *B. alopecuroides*. Three haplotypes were distributed in three individuals of *B. major* var. *japonica* and two haplotypes were found in five individuals of *B. major* var. *ovata*. Among forty three haplotypes, eight haplotypes (H1, H6, H7, H11, H14, H34, H41, and H43) were shared by two or more taxa of the complex (Table 14). Among the shared haplotypes, five (H1, H6, H7, H41, and H43) were shared by diploid and tetraploid individuals. Among forty three cpDNA haplotypes, 27 were population-specific. Forty one populations were represented by two or more individuals, and among them, eighteen populations (43.9%) contained multiple haplotypes. Thus, the number of polymorphic populations was substantial in the complex. Meanwhile, Mt. Halla of Jeju Island possessed significantly high number of haplotypes with nine haplotypes distributed over five adjacent populations identified as *B. alopecuroides*. Some populations harbored surprisingly high level of cpDNA haplotypes. For example, a total of three haplotypes were detected in four individuals sampled from a population in Mt. Oseo of Korea. H1 was the most common haplotype occurring in 34 populations (41.5% of the total). Among thirty four populations which harbored haplotype H1, thirty one were distributed in Korea only (Fig. 13). The remaining three populations with haplotype H1 were located in Russian Far East. Haplotype H1 was distributed in 15 populations of *B. pacifica*, and 17 populations from Korea identified as *B. manshuriensis* as well as two populations from Korea identified as *B. alopecuroides*. Haplotype H1 was absent in the samples of *B. manshuriensis* collected from China and Russia. Four haplotypes (H6, H7, H41 and H43) were shared by *B. manshuriensis* and *B. pacifica* (Table 14). Haplotype H11 was shared by geographically distant populations of three taxa: a population of *B. alopecuroides* from Mongolia, two populations of *B. pacifica* from Russian Far East and two populations of *B. major* var. *ovata* from Hokkaido. Two Korean accessions identified as *B. manshuriensis* shared one haplotype (H14) with a Korean sample identified as *B. alopecuroides*. One haplotype (H34) was shared by *B. major* var. *japonica* and a sample from Korea identified as *B. manshuriensis*.

(4) Phylogenetic analyses of the *B. manshuriensis* complex

The NJ tree based on six cpDNA regions is presented in Fig. 14. The NJ tree based on six cpDNA regions was highly similar to the tree based on three cpDNA regions (Fig. 14, 15). However, the number of haplotypes was reduced to 43 from 56 when only three regions were analyzed. Hence, to understand the phylogenetic relationships among the different taxa of the complex with more clarity, only three regions were selected for further phylogenetic analysis. The NJ analysis of combined cpDNA dataset of three regions (*trnK* + *matK* + *ndhF*) resulted in a single tree (Fig. 15). For bayesian analysis, MrModeltest was run which identified the following models of sequence evolution as optimal for the three cpDNA regions examined in this study; F81 for *trnK*, and GTR for *matK* and

Table 14. Distribution of cpDNA haplotypes among the populations of the *B. manshuriensis* complex and related species.

Population	Taxon/ Accession	Haplotypes																																										
		01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
B. manshuriensis																																												
M1	rs_kb1																				●																							
M2	rs_kh1–3																					●											●											
M3	rs_kh4–																					●											●											
M4	rs_kh32																					●																						
M5	rs_ot1																																									●		
M6	rs_ri1, 2						●																																					●
M7	cn_hj1									●																																		
M8	cn_hj2–4							●								●																												
M9	cn_hj5										●																																	
M10	cn_nm1				●																																							
M11	cn_ul1							●																																				
M12	cn_sb1, 2							●																																				
Korean individuals identified as *B. manshuriensis*																																												
M13	kr_od1	●																																										
M14	kr_jm1–3																																	●										
M15	kr_dg1									●																																		
M16	kr_dr1	●																																										
M17	kr_sw1, 2																												●															
M18	kr_hg1	●																																										
M19	kr_gy1	●																																										
M20	kr_nh1, 2																																		●									

Table 14. (Continued).

Popu- lation	Taxon/ Accession	Haplotypes																																								
		01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
M21	kr_gu1	●																																								
M22	kr_mp1	●																																								
M23	kr_bc1	●																																								
M24	kr_os1	●																																								
M25	kr_os2–5	●																●																									●	
M26	kr_sn1	●																																								
M27	kr_gn1, 2														●																													
M28	kr_bs1–3			●																																				●				
M29	kr_jn1	●																																								
M30	kr_bl1, 2	●																																				●						
M31	kr_jg1, 2	●																																							●			
M32	kr_mt1	●																																								
M33	kr_md1,																●																											
M34	kr_dn1, 2	●																																								
M35	kr_sm1, 2																				●																							
B. pacifica																																												
P1	rs_ms1–4											●							●																									
P2	rs_nk1, 2											●																																
P3	rs_pr1						●																																					
P4	rs_pr2, 3						●																																					●
P5	rs_rc1–3	●																																								●		
P6	rs_rc4–8	●																																					●					

Table 14. (Continued).

Popu- lation	Taxon/ Accession	Haplotypes																																										
		01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
P7	rs_us1, 2	●																																										
P8	rs_pr4						●																																					
P9	rs_pr5																																									●		
P10	cn_jl1, 2							●																																				
P11	cn_jl3, 4							●																																				
P12	cn_sn1, 2							●																																				
P13	cn_mc1,							●																																				
P14	kr_hw1, 2	●																																										
P15	kr_dm1–																										●																	
P16	kr_sk1–8								●											●																								
P17	kr_sh1																										●																	
P18	kr_gb1, 2	●																																										
P19	kr_gw1–3		●																	●																								
P20	kr_ck1, 2	●																																										
P21	kr_hc1	●																																										
P22	kr_hb1	●																																										
P23	kr_hb2	●																																										
P24	kr_mj1	●																																										
P25	kr_tb1,2	●																																										
P26	kr_tb3	●																																										
P27	kr_so1–6	●																																										
P28	kr_Il1	●																																										
P29	kr_mj1, 2					●																																						

Table 14. (Continued).

Population	Taxon/ Accession	Haplotypes																																								
		01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
P30	kr_dk1	●																																										
P31	kr_jr1	●																																										
P32	kr_jr2	●																																										
B. major var. *ovata*																																												
O1	jp_rb1											●																																
O2	jp_hk1–4											●											●																					
B. major var. *japonica*																																												
J1	jp_hn1, 2											●																																
J2	jp_ky1																																		●									
J3	jp_jp1												●																															
B. major var. *japonica*																																												
B1	cn_bj1																																			●								
B2	uk_1																																				●							
Korean individuals identified as *B. alopecuroides*																																												
A1	kr_gr1, 2	●																												●														
A2	kr_hl1–4																								●			●		●		●												
A3	kr_hl5–8																								●	●					●													
A4	kr_hl9																													●														
A5	kr_hl10–	●																						●		●																		
A6	kr_hl14														●																													
B. alopecuroides																																												
A7	mn_1													●																														
A8	mn_2											●																																

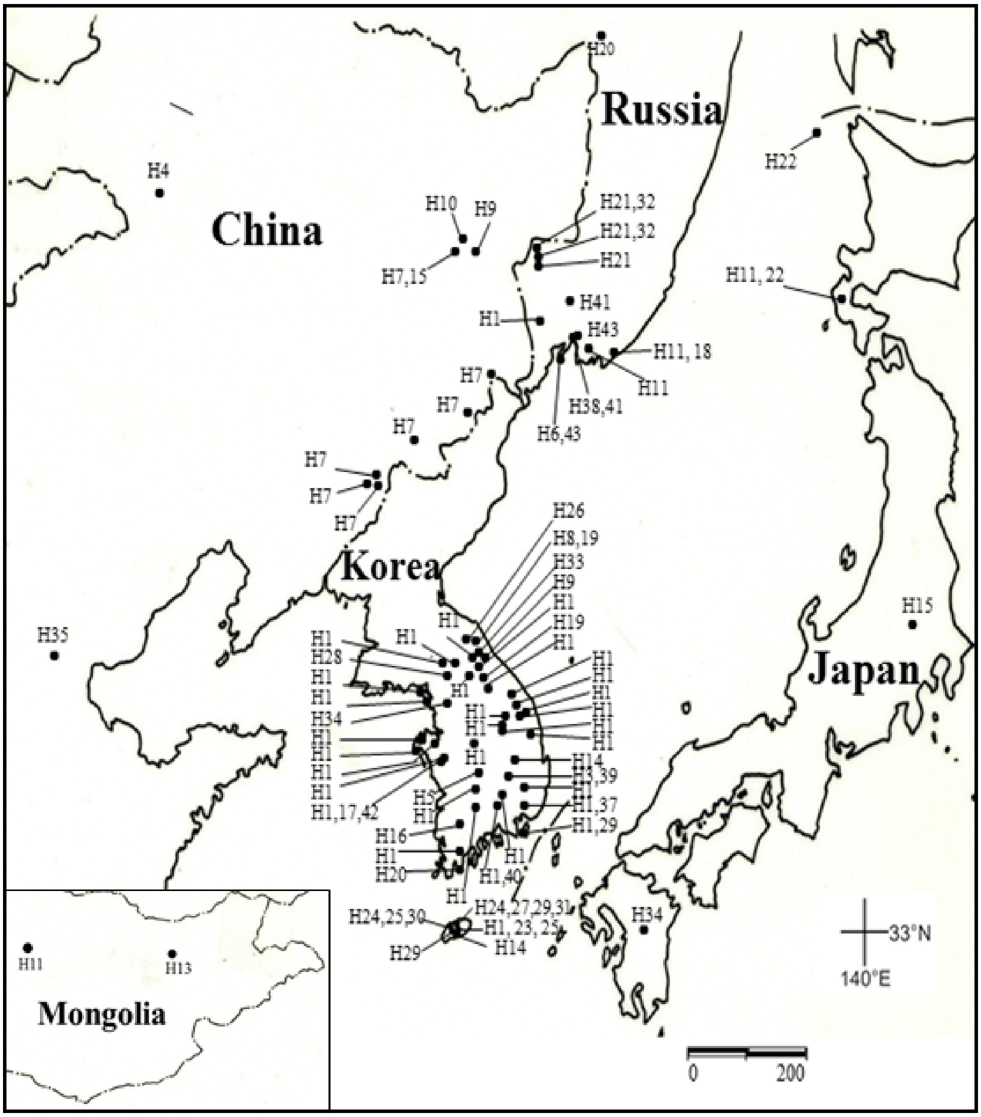

Fig. 13. Geographical distribution of 43 cpDNA haplotypes.

ndhF. The majority-rule consensus tree obtained from BI analysis of the combined cpDNA data set is shown in Fig. 16. The NJ tree and the bayesian majority-rule consensus tree were identical in topology and groupings. In both NJ and BI trees, the haplotypes of the *B. manshuriensis* complex were resolved as strongly supported monophyletic group (PP = 1; BS = 100%). However, none of the taxa of the complex were resolved as monophyletic group in the phylogenetic trees. The haplotypes were clustered into two major groups: a large lineage A consisting of 31 haplotypes and the small lineage B consisting of 12 haplotypes (Fig. 15, 16). In BI, lineage A was strongly supported (PP = 1) but poorly resolved, and consisted of samples representing all taxa within the complex and the related taxa. This clade consisted of haplotypes from *B. manshuriensis* of northeast China, most of the Korean individuals identified as *B. manshuriensis,* some individuals of *B. manshuriensis* from Khanka region, most of the individuals of *B. pacifica*, *B. alopecuroides* from Mongolia and the Korean indviduals identified as *B. alopecuroides*. Within lineage A, a group of haplotypes obtained from the samples of some Russian specimens of *B. pacifica*, Japanese individuals of *B. major* var. *ovata* and *B. major* var. *japonica* and a sample of *B. alopecuroides* from Mongolia formed strongly supported monophyletic group (PP = 1). Within lineage A, a group of haplotypes (H7, H8 and H10) consisted of individuals of *B. pacifica* and *B. manshuriensis* from northeast China and *B. pacifica* from Mt. Seorak of Korea (PP = 1).

Clade B was also strongly supported (PP = 1) and consisted of remaining accessions of *B. manshuriensis* of Lake Khanka region, Russia Island and Olenevad region, some individuals of Namhansanseong, Mt. Odae, Mt Biseul, Mt Jagul and

Mt. Oseo of Korea, *B. major* from China and UK, *B. major* var. *japonica* from Japan and *B. pacifica* from Russia. In clade B, haplotype H39 representing a diploid individual of *B. manshuriensis* with glabrous leaves formed a clade with haplotype H38 representing a tetraploid individual of *B. pacifica* having densely pubescent abaxial leaf surface (PP = 1). In addition, within lineage B, a strongly supported group (PP = 1) consisted of haplotype H34 including samples of *B. manshuriensis* from Korea and *B. major* var. *japonica* from Japan, and haplotypes H35 including an accession of *B. major* var. *major* sampled from China. Thus, the group consisted of accessions from different taxa sampled from geographically distant populations (Fig. 2, Table 2).

The other strongly supported monophyletic groups in the NJ and BI trees include; 1) a clade consisting of haplotypes H42 and H43 which consisted of samples identified as *B. manshuriensis* from Mt. Oseo and samples of *B. manshuriensis* and *B. pacifica* from Russia (PP = 1; BS = 100%), and 2) a group of haplotypes H30 and H31 oconsisting of accession identified as *B. alopecuroides* from Mt. Halla of Korea (PP = 1; BS = 95%).

(5) Haplotype network

To gain better insight into the relationships between the cpDNA haplotypes, a parsimony haplotype network was estimated (Fig. 17). The TCS network analysis (Clement et al., 2000) of the combined cpDNA sequence data matrix resulted in a single unrooted parsimony haplotype network. The network was calculated at a 95% connection limit of 27 steps. The outgroup taxa did not meet the 95% connection limit and were excluded from the analysis. The main network contained three contiguous groups corresponding to the clades recovered in the NJ and Bayesian phylogeny.

Multiple haplotypes detected from the same population were often distantly related as shown by the network (eg. Populations M6, M25, M28, M30, M31, M3, P4, P5, P6, A1; Table 2).

Fewer haplotypes occurred more than once in the samples collected in this study. Thus, a majority of haplotypes were population-specific. Some haplotypes were connected by a chain of six inferred haplotypes, suggesting fairly high genetic divergence between some haplotypes (Table 14, Fig. 17). Most populations were fixed for one haplotype, and most haplotypes were not shared among populations. The internal haplotypes H6, H7, H11 and H21 were separated from the most common haplotype of Korea (H1) by single mutation step. Meanwhile, the haplotypes detected in the individuals of *B. alopecuroides* distributed in Mongolia were separated from the haplotypes detected in morphologically similar Korean accessions identified as *B. alopecuroides* by at least two mutation steps. Some haplotypes were distributed in different taxa, for example, haplotype H1 was found in all taxa of the *B. manshuriensis* complex distributed in Korea, haplotype H7 was identified in all individuals of *B. pacifica* distributed in northeast China and most individuals of *B. manshuriensis* distributed in northeast China and Russian Far East, and haplotype H11 was found in both *B. major* var. *ovata* distributed in Japan and *B. pacifica* distributed in northeast China.

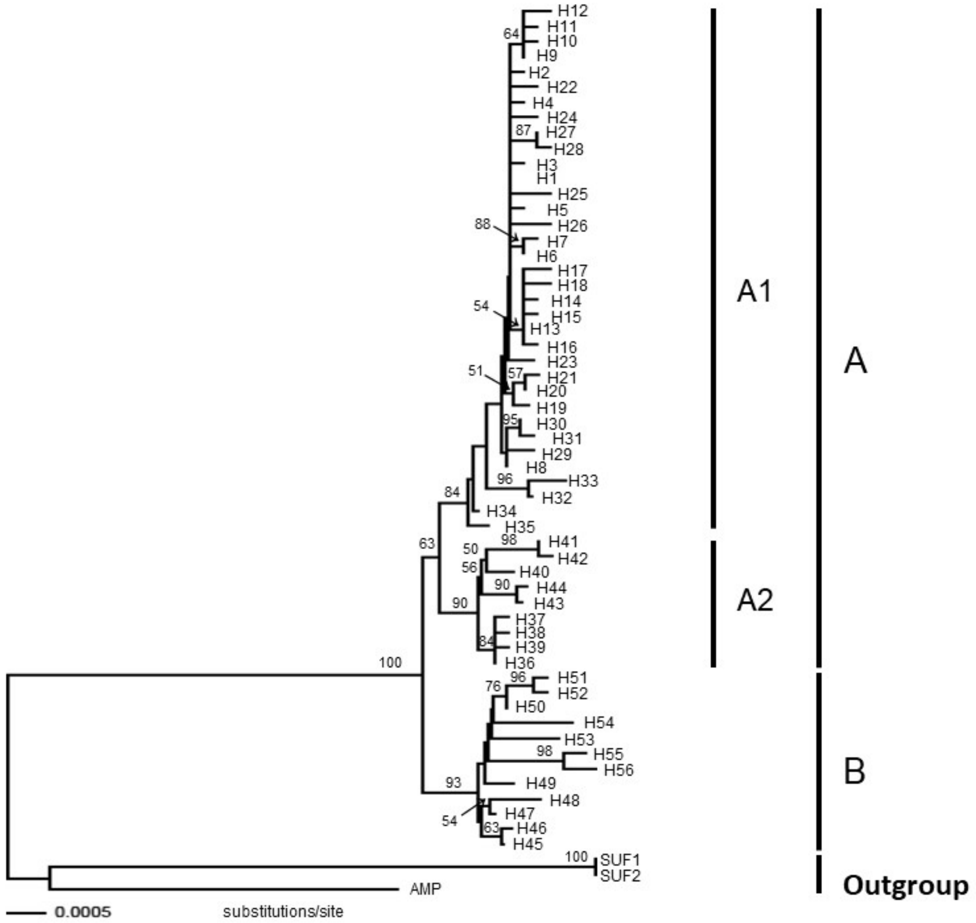

Fig. 14. A Neighbor Joining tree based on 56 haplotypes of the *B. manshuriensis* complex and related species inferred from six cpDNA regions. Numbers above branches are bootstrap values. M = *B. manshuriensis*, P = *B. pacifica*, A = *B. alopecuroides*, O = *B. major* var. *ovata*, B = *B. major* var. *major*, J = *B. major* var. *japonica*.

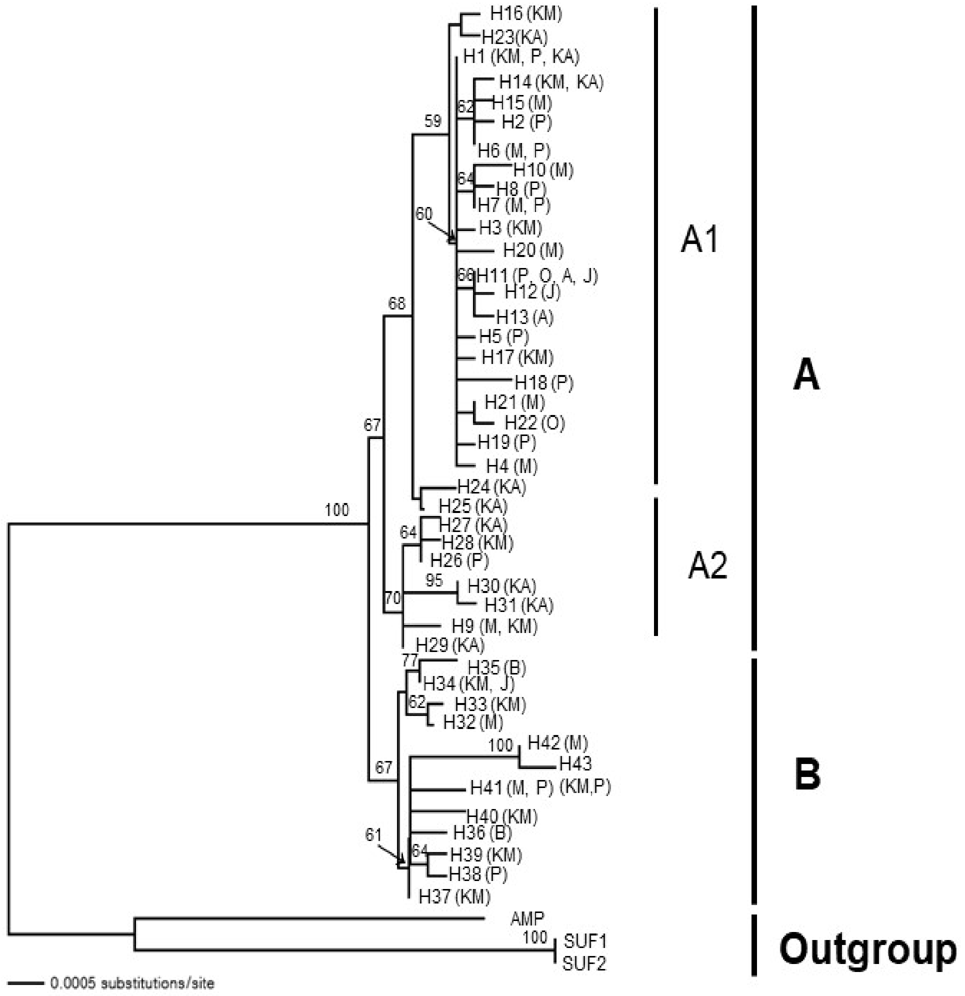

Fig. 15. A neighbor joining tree based on 43 haplotypes of the *B. manshuriensis* complex and related species based on six cpDNA regions. Numbers above branches are bootstrap values. A = *B. alopecuroides*, KA = Korean individuals identified as *B. alopecuroides*, M = *B. manshuriensis*, KM = Korean individuals identified as *B. manshuriensis*, P = *B. pacifica*, O = *B. major* var. *ovata*, J = *B. major* var. *japonica*, B = *B. major* var. *major*.

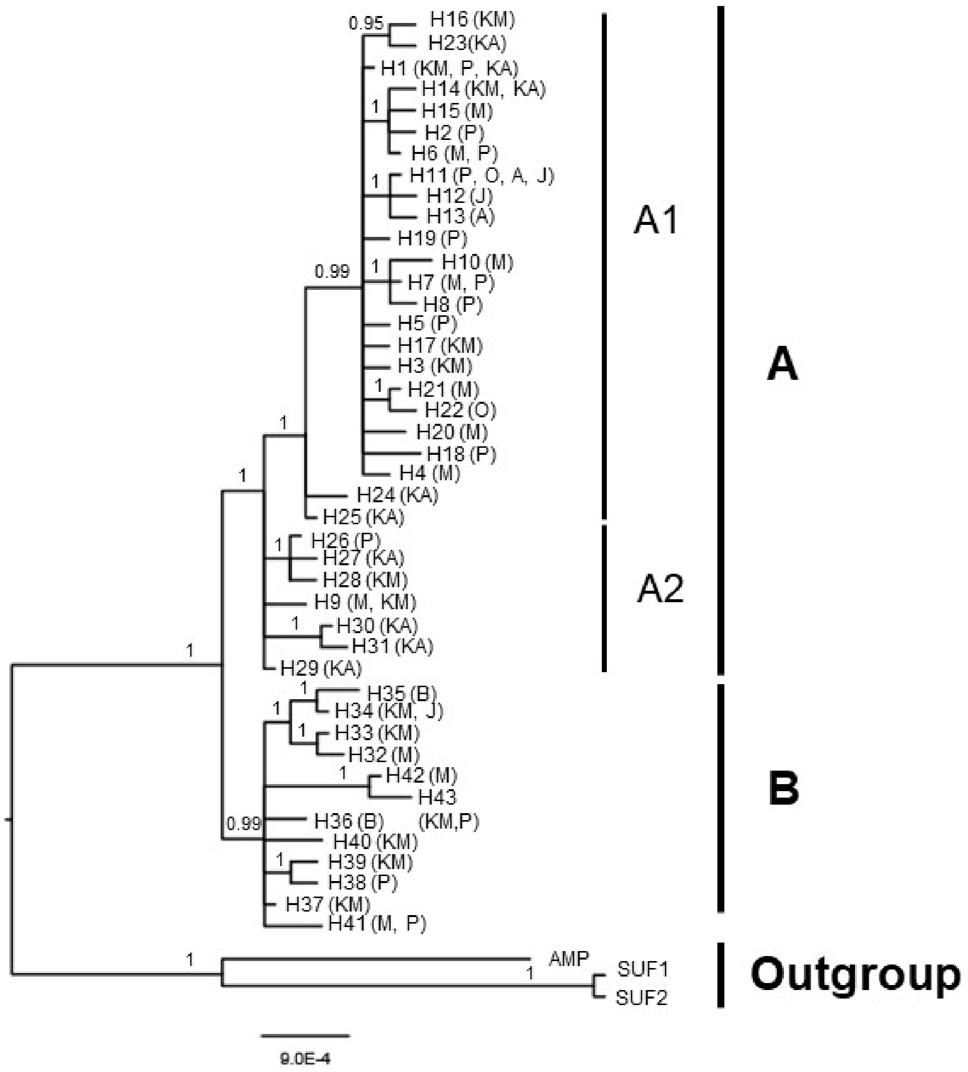

Fig. 16. A Bayesian inference tree based on 43 haplotypes of the *B. manshuriensis* complex and related species based on six cpDNA regions. Numbers above branches are posterior probabilities. A = *B. alopecuroides*, KA = Korean individuals identified as *B. alopecuroides*, M = *B. manshuriensis*, KM = Korean individuals identified as *B. manshuriensis*, P = *B. pacifica*, O = *B. major* var. *ovata*, J = *B. major* var. *japonica*, B = *B. major* var. *major*.

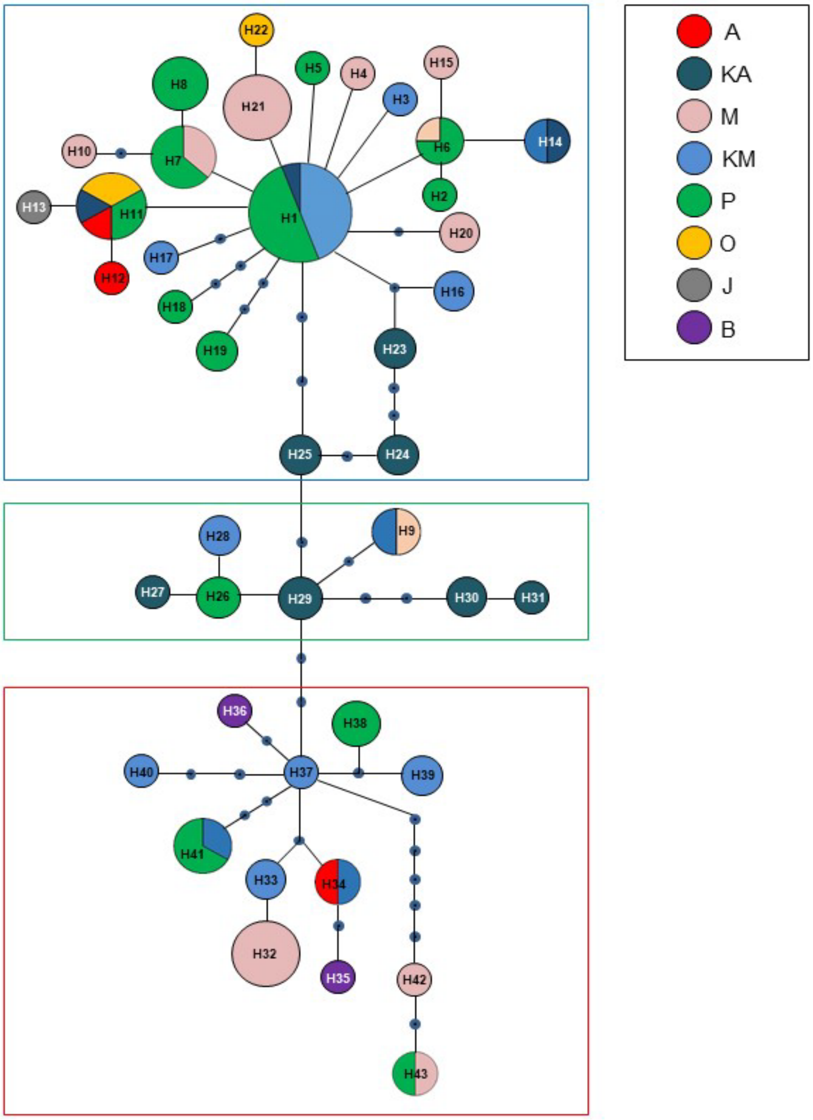

Fig. 17. TCS statistical parsimony network of the 43 cpDNA haplotypes detected in the *B. manshuriensis* complex and closely related taxa based on combined cpDNA dataset. Letters refer to haplotypes. The size of each circle reflects the number of samples with a shared haplotype. A = *B. alopecuroides*, KA = Korean individuals identified as *B. alopecuroides*, M = *B. manshuriensis*, KM = Korean individuals identified as *B. manshuriensis*, P = *B. pacifica*, O = *B. major* var. *ovata*, J = *B. major* var. *japonica*, B = *B. major* var. *major*.

IV. Discussion

Monophyly of the *B. manshuriensis* complex: Results from phylogenetic analyses of the nuclear and plastid combined data sets strongly support the monophyly of the *B. manshuriensis* complex (Fig. 11, 15). However, none of the taxa of the complex were supported as monophyletic in this study. The chloroplast data indicated a deep genetic divergence within the complex, resulting in two clades. However, the two clades did not correspond to the circumscription of species based on morphology. There was no obvious correlation between morphological and DNA sequence data. Moreover, results from the PCA showed that the taxa of the complex did not segregate distinctly. Thus, the result from morphological and molecular analyses did not support previous taxonomic treatments at the species levels based on morphology (Komarov, 1926, 1936; Nakai, 1938; Tzvelev, 1987). The result suggested that the morphological characters used to delimit the taxa were not useful for defining monophyletic groups. Though exons, introns and intergenic spacers of cpDNA were sequenced in this study with a total aligned length of 5785 bp, to utilize different rate of evolution of different regions for resolving phylogenetic relationship among the taxa of the complex, variation in the sequence data weakly resolved relationship among the taxa. Previous studies in *Aquilegia* (Hodges and Arnold, 1994) and *Lupinus* (Huang and Friar, 2011) have also shown that variation in chloroplast DNA sequences is sometimes insufficient to resolve the phylogenetic relationships in some plant group, even with large morphological divergence.

ITS polymorphisms: In phylogenetic studies at low taxonomic levels, ITS sequences have been found to provide greater level of divergence than cpDNA sequence (Baldwin et al. 1995; Sang et al., 1997; Soltis and Soltis 1998; Álvarez and Wendel, 2003). However, in the present study, ITS sequences showed lower level of overall divergence and lacked striking genetic differentiation observed in cpDNA. Analysis of ITS sequences showed that fifty seven of the 84 individuals analyzed in this study contained two or more ribotypes. All taxa of the *B. manshuriensis* complex were polymorphic and some individuals of the complex contained as many as seven ribotypes. The maximum number of ribotypes found in an individual in the *B. manshuriensis* complex was higher than the number found in other taxa of Polygonaceae (Kim and Donoghue, 2008; Wan et al., 2014). Intra-populational sequence divergence was relatively common in the complex. Among the 28 ribotypes found in the complex, eight were shared by two or more taxa of the complex. Ribotype R1 was found in all taxa of the complex which suggested their origin from a common ancestor.

Hybridization, long generation time and polyploidy are some of the main factors that account for ribotype polymorphism in plants. It is likely that these factors contributed to the intraindividual polymorphism that was detected in the taxa of the *B. manshuriensis* complex. Both interspecific and intraspecific hybridization events bring together different alleles from different parental sources into a single genome and therefore can give rise to intraindividual polymorphism (Koch et al., 2003). Clonal propagation through rhizome has been suggested in *B. officinalis* (Kostrakiewicz-Gierałt, 2013) and possibly occurs in the taxa of *B. manshuriensis* complex as ramets connected to the rhizome have been found in many instances in the field (pers. obs.). Clonal propagation leads to a longer generation time, which in turn reduces the rate of concerted evolution resulting in ribotype polymorphism (Sang et al., 1995). Similar results of high ribotype polymorphism has been demonstrated in *Carapichea ipecacuanha* which propagates clonally with infrequent sexual reproduction (Sousa Queiroz et al., 2011).

Polyploidization is another factor that could favor the maintenance of intraindividual polymorphism, because it is less likely that copies of nuclear DNA on different chromosomes will undergo homogenization than copies on the same chromosome (Campbell et al., 1997). Although the number of copies and chromosomal locations of nuclear DNA in the species of *Bistorta* are unknown, polyploidy has been found in some species including *B. officinalis and B. vivipara* (Doida, 1960; Löve, 1954; Löve & Löve, 1974; Goldblatt, 1988; Krogulevich & Rostovtseva, 1984; Krahulková, 1990). Hence, a majority of the taxa of the complex might contain nuclear DNA arrays in distinct locations within the genome retaining nuclear DNA polymorphism.

Haplotype polymorphisms: The taxa of the *B. manshuriensis* complex showed high level of within and among population variation in chloroplast sequences. Among 41 of 81 populations from which two or more accessions were sampled, eighteen (43.9%) contained multiple haplotypes. The number of haplotypes found in the *B. manshuriensis* complex was comparable to the number found in the circumpolar arctic-alpine herb *Oxyria digyna* (Allen et al., 2012), eventhough the latter was sampled from 140 localities compared to 81 localities sampled in this study.

TCS parsimony network analysis revealed that one haplotype (H1) was shared across three taxa and several other haplotypes were shared between two taxa. All taxa contain both shared and population-specific haplotypes. Haplotype sharing between closely related species has been found in a number of genera such as *Artemisia* (Shimono et al, 2013), *Betula* (Palme et al, 2003); *Achillea* (Guo et al., 2012). Sharing of different cpDNA haplotypes could be explained by i) interspecific gene flow, ii) ancestral polymorphism and incomplete lineage sorting and iii) mutation and allopatric divergence. The three explanations are not mutually exclusive and may act together. Firstly, previous phylogenetic studies among species using chloroplast DNA variations have shown that chloroplast captures occur frequently in many plant species groups (Rieseberg and Soltis, 1991). However, current hybridization between taxa of *Bistorta* is unlikely because accessions from populations with geographical proximity did not always form a monophyletic group and some clades in the phylogenetic tree consisted of accessions separated by large geographical distances. If hybridization is to be evoked for the explanation of the grouping of distant populations in clade B, gene flow may have occurred in remote past via seeds across a broad geographical scale. It is often difficult to distinguish hybridization from incomplete lineage sorting, as the cause of sharing of haplotypes at both scenarios produce a similar pattern of allele sharing (Wendel and Doyle, 1998; Muir and Schlotterer, 2005). Secondly, incomplete lineage sorting is a factor that complicates the use of cpDNA in phylogenies as it can be easily misinterpreted as evidence of interspecific gene flow (Schaal and Olsen, 2000). In the present study, haplotypes were also shared between distant populations of same or different taxon in the complex in some cases. Haplotype H1 and H7 was shared between the taxa of different ploidy level. In 18 of the 41 populations with multiple sampling, intrapopulation cpDNA polymorphism was detected. These results indicated persistence of ancestral haplotype polymorphism as a result of incomplete lineage sorting. There are several other examples where incomplete lineage sorting of ancestral polymorphisms has been identified as the most likely cause of the incongruence between cpDNA phylogeny and morphology (Lavin et al., 1991, Mayer and Soltis, 1994; Mason-Gamer et., 1995; Byrne et al., 2002). Thirdly, independent origin of haplotypes in isolated population due to mutation and allopatric divergence of populations in isolated microrefugia could also be responsible for relatively large number of population-specific cpDNA haplotypes. High number of population-specific haplotypes as a result of mutation in isolated refugia was suggested in several alpine plants of northeast Asia such as *Arcterica nana* (Ikeda and Setoguchi, 2006), *Cardamine nipponica* (Ikeda et al. 2008b) *Diapensia lapponica* subsp. *obovata* (Ikeda et al. 2008a). TCS stastistical parsimony analysis of cpDNA revealed that the *B. manshuriensis* complex contained both shared and population-specific haplotypes. Haplotype H1 was dominantly distributed in Korea. An ancestral haplotype is expected to occupy a central position within a haplotype network and consequently have more mutational connections to other haplotypes (Crandall and Templeton, 1993). Given that the frequent haplotype (H1) was in the central position of the network, H1 was the probable ancestral haplotype in the complex. Haplotype H1 was distributed in 31 populations in Korea and three populations in Russian Far East. The population-specific haplotypes were either divergent haplotypes or derived from shared ancestral haplotypes. Population-specific rare haplotypes may have diverged from the widespread haplotype H1 after colonization into each population as most of the population-specific haplotypes were separated from the most common haplotype by one or two mutation steps. The distribution pattern of haplotypes (Fig. 13) indicated when northern Japan, Russian Far East, northeast China and Korea were treated as separate regions, each region had usually region-specific haplotypes. For example, the common haplotype H1 was found in Korea and Russian Far East and haplotype H7 was restricted to the populations in northeast China only. Thus, haplotypes appeared to be distributed nonrandomly. Shared haplotypes were usually restricted to neighboring populations in each region, suggesting that the gene flow occurred mainly among the neighboring populations within the same geographic region (Fig. 13). Presence of region-specific haplotypes and few shared haplotypes among regions suggested genetic isolation of each region for long periods. Some adjacent populations, particularly in Russia, harbored divergent haplotypes (Fig. 13, 17). Majority of the populations were monomorphic containing single haplotype; although if more individuals per population were analyzed, more haplotypes might be detected.

Although seeds of the taxa in the *B. manshuriensis* complex lack morphological adaptation to long-distance dispersal, they are probably dispersed by birds similar to many other taxa of Polygonaceae (Croat, 1978). Most of the haplotypes had narrow distribution range. The populations carrying identical (shared) haplotypes were often located adjacently supporting the hypothesis of short-distance dispersal of seeds and restricted gene flow. The wide distribution of haplotype H1 indicated that the gene flow may have occurred via seeds to the current distribution area in the remote past indicating historical gene flow in once continuous ancestral population. Alternatively, the result may suggest occasional long-distance dispersal of seeds which is less likely given the wide distribution of only one haplotype.

Large number of unobserved haplotypes revealed by the haplotype network indicated severe population bottlenecks which resulted in the extinction of many intermediate haplotypes. This was more evident in Russian Far East where many diverging lineages were found. The results were consistent with the fact that the region lies in high latitude and may have experienced severe climatic fluctuations (Hewitt, 2004) during Pleistocene. This may have resulted in population bottlenecks and some populations survived in isolated microrefugia.

All populations of the *B. manshuriensis* complex sampled from high mountains near the border between China and Korea harbored haplotype H7 that was separated from the dominant haplotype (H1) by single mutation step (Fig. 17). The result suggested recent single introduction. Alternatively, the result could indicate population bottlenecks as the high mountains of the region was glaciated during the last Pliestocene glaciation (Kano, 1937; Kong and Watts, 1993; Shi, 2002) and the populations/species that occur in formerly glaciated regions usually show lower levels of genetic diversity than those from unglaciated areas as a result of founder effects or population bottlenecks (Hewitt, 1996; Jimenez et al., 2010; Widmer and Lexer, 2001).

Variation of the tetraploid complex: The individuals of *B. pacifica*, and *B. major* var. *ovata* and *B. alopecuroides* were tetraploid. However, even with the extensive sampling for chromosome counts, including 66 individuals in 53 populations, triploid ($2n$ = 36) individuals were not found in this study suggesting that the diploid and tetraploid taxa are reproductively isolated and gene flow occurred between or among the taxa of the same ploidy level. Meanwhile, *B. major* var. *ovata* distributed in japan and *B. pacifica* were morphologically similar and were clustered together in multivariate analysis. An examination of type specimens of *B. pacifica* and *B. major* var. *ovata* deposited in LE and TI respectively indicated that the two taxa are morphologically similar. In PCA, Axis II separates *B. pacifica* weakly from the cluster of accessions from Korea and Russia recognized as *B. manshuriensis*. The major characters that contributed to Axis II were leaf blade length of basal leaf, position of the maximum width in leaf blade and length of petiole wing.

Many individuals of *B. pacifica* and all individuals of *B. major var. ovata* contained two or more ribotypes which resolved in different clades suggesting gene flow among the taxa. Meanwhile, two ribotypes (R10 and R11) were shared by some individuals of *B. pacifica* and *B. major* var. *ovata* only (Table 11). In addition, some individuals of *B. pacifica* from Russia and *B. major* var. *ovata* had identical haplotypes. The results from molecular, morphological and chromosome analysis, thus, supports the inclusion of *B. major* var. *ovata* in *B. pacifica*.

Variation of the diploid complex: The individuals of *B. manshuriensis* collected from Russian Far East and northeast China were diploids. An examination of the type specimens of *B. manshuriensis* deposited in LE revealed that the type specimens were heterogenous mixture of individuals with and without basal leaves. The lectotype, however, seems to actually represent *B. manshuriensis* since this specimen was proposed as the type specimen by original author (*nomen nudum* by Petrov). The lectotype of *B. manshuriensis* is morphologically similar to some specimens collected from Northeast China and Russian Far East for the present study, in having smaller rhizome, absence of basal leaves, thin papery and glabrous cauline leaves and auriculate sagittate base of middle and upper cauline leaves. These specimens, however, could not be included in PCA due to lack of basal leaves. DNA sequence analysis revealed the presence of one to two ribotypes in these individuals. In total, there were three ribotypes distributed in these individuals including the most common ribotype R1. The other two ribotypes were population-specific. In addition, Russian and Chinese individuals harbored nine cpDNA haplotypes. The general haplotype H1, which was commonly distributed in the Korean populations identified as *B. manshuriensis,* was absent in the Russian and Chinese populations of *B. manshuriensis*. Among nine haplotypes, two (H9 and H20) were shared with the Korean individuals identified as *B. manshuriensis*. Haplotype H9 was shared by a population (M7) in Northeast China and a population (M15) in Korea. Similarly, H20 was shared by a population (M1) in Russian Far East and a population (M35) in southern coast of Korea. The relatively larger geographical distance between these populations suggested retention of ancestral haplotype polymorphism by incomplete lineage sorting rather than hybridization. Thus, the result obtained from morphological and molecular data suggested that *B. manshuriensis* is distributed in Northeast China and Russian Far East and the Korean populations identified as *B. manshuriensis* actually represented a different taxon.

Bistorta manshuriensis was first reported in Korea by Nakai (1938). Many subsequent taxonomists supported the occurrence of *B. manshuriensis* in Korea (Park, 1974; Lee, 1980; Lee, 1996; Park and Hong, 2007). Lee (1996), however, recognized this species as *Bistorta major* var. *japonica*, excluding *B. manshuriensis* from the flora of Korea. The type specimens of *B. manshuriensis* deposited in LE clearly differ from Korean specimens in having smaller rhizome, absence of basal leaves, thin papery cauline leaves and auriculate sagittate base of middle and upper cauline leaves. The Korean specimens were morphologically more similar to Japanese specimens of *B. major* var. *japonica* collected for this study, and a thorough examination of the specimens including type specimens of *B. major* var. *japonica* deposited in TI further confirmed it. In PCA, the Korean specimens formed a cluster together with the specimens collected from Khanka region of Russia. This cluster was partially overlapped with the cluster of *B. pacifica* and *B. major* var. *ovata* on lower side of the plot as well as the Korean specimens recognized as *B. alopecuroides* on the left side. Axis I weakly separated cluster of the Korean individuals identified as *B. manshuriensis* and *B. alopecuroides*. The major characters that contributed Axis I were Leaf blade width at 1/3, 1/2 and 2/3 point of leaf blade, leaf blade width at the widest point and ratio between width and length of leaf blade.

Korean specimens identified as *B. manshuriensis* were diploids. The ITS sequence of all Korean individuals had overlapping peaks in electropherogram, and two to four ribotypes were recovered from each individual after cloning. In total, seven ribotypes were recovered from Korean individuals identified as *B. manshuriensis*. Among the seven shared ribotypes, five were shared with Korean specimens of *B. pacifca* and the specimens from Jeju Island identified as *B. alopecuroides*. Thus, the result suggested close relationship among Korean individuals of the *B. manshuriensis* complex. Thirteen cpDNA haplotypes were found in the Korean individuals identified as *B. manshuriensis*. Among thirteen haplotypes, only two haplotypes were shared with *B. manshuriensis*, one shared with an individual from China and the other shared with an individual from Russia. Nine of the thirteen haplotypes were population-specific suggesting a lower rate of gene flow via seeds. Taken together, the result suggested that the Korean individuals are morphologically and genetically distinguishable from *B. manshuriensis*. The Korean individuals are distinct from *B. pacifica* on the basis of chromosome number. Korean individuals identified as *B. manshuriensis* and *B. alopecuroides* were separable on the basis of morphology of basal leaves, though the two entities were genetically and cytologically close to each other.

Bistorta alopecuroides, originally described from Chita near lake Baikal, was first reported in Korea (Mt. Halla) by Nakai (1938). The occurrence of *B. alopecuroides* in Mt. Halla was also reported by later taxonomists (Park, 1974; Lee, 1980; Lee, 1996; Park and Hong, 2007). Lee (1996), however, recognized *B. major* var. *angustifolia* from Mt. Halla and Yonekura (2006) suggested that the individuals of Mt. Halla represent *B. officinalis* subsp. *japonica*. Based on field collections of *B. alopecuroides* from Mongolia and Mt. Halla of Jejudo and a comparison with the type specimens deposited at LE, it was found that the individuals of Mt. Halla differ remarkably from *B. alopecuroides* in several characteristics such as plant height, stem diameter, shape and size of basal and cauline leaves leaf pubescence, and inflorescence length. Moreover, in the chromosome counts carried out in the present study, the individuals of Mt. Halla were found to be diploids ($2n = 24$) compared to tetraploid ($2n = 48$) individuals of *B. alopecuroides* sampled from Mongolia. Two ribotypes were identified in each of the two specimens sampled from Mongolia, one was the common ribotype R1 shared across the taxa of the complex and the other (R13) was shared with two individuals from two populations of *B. pacifica* from Russia and an individual of *B. major* var. *ovata* sampled from Hokkaido, Japan. Thus, except the general ribotype R1, other ribotypes were not shared between *B. alopecuroides* and the individuals of Mt. Halla identified as *B. alopecuroides*. Similarly, one cpDNA haplotype (H11) was shared with two populations of each of *B. pacifica* and *B. major* var. *ovata* and a population of *B. major* var. *japonica*. Haplotypes were not shared between Mongolian individuals of *B. alopecuroides* and Korean individuals identified as *B. alopecuroides*. Thus, the individuals of *B. alopecuroides* collected from Mongolia showed higher affinities to *B. pacifica*, *B. major* var. *japonica* and *B. major* var. *ovata*, rather than individuals of Jeju Island identified as *B. alopecuroides*. Thus, Jeju populations were morphologically, cytologically and genetically distinguishable from *B. alopecuroides*.

V. Conclusion

This is the first molecular phylogenetic study to include comprehensive sampling of the taxa of the *B. manshuriensis* complex and related taxa from most of their range of distribution. The result of comparative analysis including PCA showed that *B. manshuriensis*, *B. pacifica* and *B. alopecuroides* were separated weakly based on leaf length, leaf shape and maximum width of basal leaves.

The ITS tree and cpDNA tree based on combined data revealed that the *B. manshuriensis* complex is monophyletic (PP = 1.0, BS = 100%). Multiple ribotypes and haplotypes were found in each taxon of the complex. Some of the taxa of the complex had shared haplotypes and ribotypes. Some individuals of the taxa had two or more ribotypes which resolved in different clades suggesting occurrence of gene flow among the taxa and populations of the complex. The results suggested that the taxa of the complex originated from a common ancestor and due to the persistence of ancestral haplotype polymorphism as well as hybridization lead to the complex relationship within the species complex.

On the basis of chromosome numbers, the individuals of *B. pacifica* were clearly distinguishable from *B. manshuriensis* distributed in China and Russia as well as Korean individuals identified as *B. manshuriensis* and *B. alopecuroides*. However, even with the extensive sampling including 66 individuals in 53 populations, triploid ($2n = 36$) individuals were not found suggesting that the diploid and tetraploid taxa are reproductively isolated and gene flow occurred between or among the taxa of the same ploidy level. Meanwhile, *B. major* var. *ovata* distributed in japan and *B. pacifica* had identical ploidy level and were also indistinguishable from each other based on morphological analysis. In addition, some individuals of *B. pacifica* from Russia and *B. major* var. *ovata* had identical haplotypes. The results from molecular, morphological and chromosome analysis, thus, supports the inclusion of *B. major* var. *ovata* in *B. pacifica*. Meanwhile, although, the individuals of *Bistorta* distributed in Mt. Seorak were very similar to the individuals of *B. pacifica*, they are distinguishable by relatively narrow lamina of basal leaves, curved basal and cauline leaves with undulate margin and the presence of linear second cauline leaf from the top. Moreover, the individuals were diploids (2*n* = 24) which warrant their recognition as a new species.

The Korean individuals identified as *B. manshuriensis* were found morphologically distinct from the type specimens of *B. manshuriensis* deposited in LE, but rather more similar to the type specimen of *B. major* var. *japonica* deposited in TI. It appears to be more to treat he Korean individuals, previously identified as *B. manshuriensis* as *B. major* var. *japonica*. The type specimen deposited in LE was morphologically identical to some diploid individuals collected from Northeast China and Russian Far East for this study. Relatively large number of cpDNA haplotypes recovered from these individuals, however, did not form monophyletic group in the phylogenetic tree. The result indicated that the speciation in *B. manshuriensis* a complex evolutionary process involving incomplete lineage sorting, hybridization and introgression as well as geographical divergence.

The individuals of *B. alopecuroides* and the Korean individuals recognized as *B. alopecuroides* had different chromosome numbers and possessed different cpDNA haplotype and ribotypes. The result suggested that Korean populations recognized as *B. alopecuroides* actually represent a distinct taxon.

On the bases of these results, three species and two subspecies, including one new species, were recognized in the complex in northeast Asia and description of all taxa and keys to the taxa are provided.

VI. Taxonomic treatment

Bistorta (L.) Scop., Meth. Pl. 24, 1754.

Polygonum [unranked] *Bistorta* L. Sp. Pl. 360, 1753. *Polygonum* sect. *Bistorta* (L.) D. Don, Prodr. Fl. Nepal. 69, 1825. *Polygonum* sect. *Persicaria* subsect. *Bistorta* (L.) Benth. & Hook. f., Gen. Pl. 3: 98, 1880. Lectotype: *Polygonum bistorta* L. (≡ *Bistorta officinalis* Delarbre), designated by Haraldson, Symb. Bot. Upsal. 22: 75, 1978.

Korean name: Beom-Kko-ri-Sok (범꼬리속）

Herbs, rarely subshrubs, perennial, monoecious or dioecious, rhizomatous; rhizomes thickened, short and tortuous or elongated and moniliform to thin, ligneous and stoloniferous, fleshy or woody, usually white or reddish white in the cross section. Stems erect or ascending, or [rarely prostrate], usually simple, terete, glabrous. Leaves basal [=radical] and cauline, basal leaves rosette, simple; leaf blade membranous or coriaceous, linear, lanceolate, elliptic to ovate, apex obtuse or acute to acuminate, cuneate or truncate to cordate at base, pinnately veined, margin entire or obscurely and irregularly undulating, revolute or flat, with or without thickened veins at margin, glabrous to densely pubescent at lower surface, long petiolate, not articulated, petiole winged near junction with blade or unwinged; cauline leaves alternate, simple, lower cauline leaves petiolate, middle and upper ones sessile and weakly or strongly amplexicaul, lower cauline leaves disintegrating with age; ocreae of lower cauline leaves broadly rounded, green basally, brownish distally, chartaceous, completely surrounding the nodes, oblique at apex, sometimes lacerate, eciliate at margin, ochrea of upper leaves truncate at apex. Inflorescences usually terminal or rarely terminal and axillary, simple or rarely branched, spike-like, mostly compact, globose to cylindrical in outline, consisting of monochasia (helicoid cymes), rarely bearing bulbils in lower part; each cyme 1–5-flowered, closely spaced and more or less compact, subtended by a bract; bracts ovate or lanceolate, scarious, entire or toothed at margin, eciliate; pedicels articulated at base of perianth, bearing paired scarious bracteoles. Flowers bisexual or unisexual; perianth deeply rarely 4- or 5-parted, deep red or pink, white to whitish-green; tepals subequal, mostly persistent, not accrescent in fruit; stamens 8, inserted at the base of perianth in one or two whorls, included or exserted, filaments white, flattened; nectaries of two kinds: outer ones free (sometimes absent), inner ones fused with the filament bases. Style 1, 2- or 3-cleft, 3–4 mm long, exserted; stigmas 2 or 3, very small, minutely capitate. Achenes trigonous or rarely biconvex, included or exserted, brown ro black, shiny or dull, smooth, tuberculate. Chromosome number 2*n* = 24, 48.

Species ca. 50 (9 in Korea).

Distribution: Mostly in temperate to alpine regions of Northern Hemisphere.

Bistorta [(L.) Scop.] is a taxonomically difficult genus that includes approximately 30 to 50 species worldwide (Yonekura and Ohashi, 2001; Li et al., 2003; Freeman and Hinds, 2005; Galasso et al., 2009). The defining features of the genus *Bistorta* are perennial habit, stout and contorted rhizome; presence of basal leaves, revolute leaf margin with broad nerves on the edges, long, cylindrical and oblique ochrea, terminal and/or axillary spike-like cyme with dense flowers, 5-parted perianth, presence of eight free stamens, nectaries united with the base of inner stamens and tricolpate type of pollens (Greene, 1904; Hedberg, 1946; Haraldson, 1978; Ronse Decrane and Akeroyd, 1988). In Korea, about 9–11 species of *Bistorta* have been reported, one of them being endemic. The species of *Bistorta* have complex pattern of variation in morphology depending on geography and environment. Due to the continuous variation in morphological characters in some taxa, their taxonomic status, taxonomic boundary and ranking are controversial among the authors (Nakai, 1938; Park, 1974; Lee, 1980; Lee, 1996; Lee, 1996).

The *Bistorta manshuriensis* species complex includes closely related and controversial taxa: *B. manshuriensis* (Petrov ex Kom.) Kom. ex Nakai, *B. pacifica* (Petrov ex Kom.) Kom. ex Nakai and *B. alopecuroides* (Turcz. ex Besser) Kom. and two taxa from Japan supposed to be closely related to the complex: *B. major* var. *japonica* (H. Hara) Yonek. and *B. major* var. *ovata* Nakai ex H. Hara. The species of the complex have been circumscribed either in series or in section *Bistorta* (Komarov, 1936; Tzvelev, 1987; Yonekura, 2006). The Korean members of the complex are mainly distinguished on the basis of size and shape of leaf blade, broadness of petiole wing, tepal color. However, there is complex pattern of morphological variation among the species and some groups are characterized by intermediate morphological characters. Hence, it has been difficult to delimit species boundary and to clarify relationships between the closely related taxa of different geographical region.

Detailed study of herbarium specimens (including type specimens), field visits, protologues, taxonomic literature, principal components analysis (PCA), and chromosome counts has allowed to revise taxonomy of the species of the *B. manshuriensis* complex in this study. The species treated here have been primarily circumscribed by unique combination of basal leaf characters. Chromosome counts and DNA sequence data provided additional support for species circumscription. In some cases, a comparison with type specimens was performed. Many of the characters used by former authors to delimit taxa of the complex turned out to be highly variable with some characters seen as not suitable for species delimitation. In general, consistency in shape and size of radical leaf as well as chromosomal numbers was found to discriminate between species. On the basis of this study, four species and two subspecies were recognized in the *B. manshuriensis* complex in northeast Asia and the description of all taxa and keys to the taxa are presented.

Key to the species of the *Bistorta manshuriensis* complex

1. Basal leaves lanceolate, oblong, triangular to narrowly ovate, base cuneate, truncate or subcordate, middle and lower cauline leaves lanceolate.
    2. Basal leaves usually absent, leaves papery, glabrous, veins on the leaf margins not distinctly thickened …..…………..….… 1. *B. manshuriensis*

2. Basal leaves always present, leaves membranous, glabrous or pubescent abaxially, veins on the leaf margins usually distinctly thickened.
    3. Basal leaves lanceolate oblong, triangular to narrowly ovate ………………..…………………….….………..2. *B. officinalis*
    3. Basal leaves lanceolate to oblong ………. 3. *B. alopecuroides*

1. Basal leaves narrowly to widely ovate, base cordate, middle and lower cauline leaves ovate to lanceolate.
    4. Basal leaves widely ovate, second cauline leaf from the top lanceolate or ovate, leaf blade glabrous or pubescent …………...…….. 4. *B. pacifica*
    4. Basal leaves narrowly ovate, second cauline leaf from the top linear, leaf blade glabrous …………..…..…………………….…….... 5. *B. koreana*

Species description

1. ***Bistorta manshuriensis*** (Petrov ex Kom.) Kom. ex Nakai, J. Jap. Bot. 14: 737, 1938.

Polygonum manshuriense Petrov ex Kom., Bot. Mater. Gerb. Glavn. Bot. Sada S.S.S.R. 6: 3, 1926. Type: China. Manshuria: "Ninguta, in pratis ad trajectum Loe-lin non procul a pago Taimagou", 13 Jul 1896, *Komarov s. n.* (lectotype: LE [not seen]); Russia. "Chabarovsk in pratis humidiusculis", 12 Jul 1902, *N. Desoulavy 153* (syntype: LE [not seen]); "ad sinus Chadshi-bai, Sovietscaja nuncdicta, 40 km, a litus mar. in pratis ripariis secus fl.", without date, *N. P.*

Krylov s. n. (syntype: LE [not seen]); "in valle fl. Botscha (48° lat. s.) in pratincolis silvaticis" 28 Jul 1924, *I. K. Schischkin* 122 (syntype: LE [not seen]); "ad fontes fl. Botscha in pratis subalpinis supra limites arborum", 30 Aug 1924, *I. K. Schischkin 564* (syntype: LE [not seen]).

Korean name: Man-ju-beum-kko-ri (만주범꼬리)

Rhizomes ca. 0.5 cm in diam. Stems usually 1, sometimes 2. Leaves: basal leaves absent; cauline leaves membranous, glabrous, lanceolate, acuminate at apex, bases cuneate, decurrent along petiole forming narrow or wide wings, veins not distinctly thickened at margin, upper cauline leaves strongly amplexicaul, auriculate, base cordate, subsessile, uppermost cauline leaf filiform or lanceolate; ocrea 3–12.3 cm long, glabrous. Inflorescences terminal, 3.5–7.5 cm long, ca. 0.8–1.2 cm in diam.; helicoid cymes 2- or 3-flowered, closely spaced; bracts narrowly ovate to elliptic, 2–3 mm long, membranous, translucent, cuspidate at apex. Flowers pink, tepals elliptic, rounded at apex; ca. 2.4 mm; stamens exserted; filaments 2.8 mm long, anthers dark brown; style 3-cleft at base, exserted. Achenes orbicular in outline, ca. 3 x 2 mm, enclosed, dark brown, sharply trigonous, shiny. Chromosome number: $2n = 24$.

Flowering Jun to Aug.

Distribution: northeast China, Russian Far East.

Bistorta manshuriensis was first reported in Korea by Nakai (1938), who was followed by subsequent Korean authors (Park, 1974; Lee, 1980; Lee, 1996; Park and Hong, 2007). Some Korean authors, however, did not recognize this species as part of the Korean flora (Chung, 1957; Lee, 1996). The type specimens of *B. manshuriensis* deposited in LE clearly differ from Korean specimens in having smaller rhizome, absence of basal leaves, thin papery cauline leaves and auriculate sagittate base of middle and upper cauline leaves. The type specimens are similar to the specimens collected from northeast China and Russian Far East in present study. Moreover, the type specimens appear to be heterogenous comprising highly dissimilar specimens. The lectotype, however, seems to correctly represent *B. manshuriensis*. The Korean specimens are more similar to Japanese specimens of *B. major* var. *japonica* and an examination of the type specimen of *B. major* var. *japonica* deposited in TI further confirmed it. Hence, *B. manshuriensis* is excluded from the Korean flora, and Korean specimens identified previously as *B. manshuriensis* are transferred to *B. major* var. *japonica* (≡ *B. officinalis* subsp. *japonica*) in this study.

Additional specimens examined: CHINA. Heilongjiang: Mudanjiang, Hailin, Changting town, Shuangfeng Forest Farm, China's snow town, 20 Jul 2015, *G. S. Bhandari & T. Y. Choi 3–7* (SNU); Mt. Bonghwa, 20 Jul 2015, *G. S. Bhandari & T. Y. Choi 9–11, 13-1, 13-2, 14, 15-1, 15-2, 16–19, 22-1, 22-2, 23, 24-1, 24-2, 28, 29, 39-1–39-4, 40, 42-1–42-4* (SNU); 11 Jul 2016, *C. W. Park & T. Y. Choi 74–83* (SNU); Harbin, Shangzhi, San Hao Tun, 21 Jul 2015, *G. S. Bhandari & T. Y. Choi 46, 47* (SNU). Jilin: Yanbian, Helong city, 24 Jul 2014, *T. Y. Choi 35–45* (SNU);

Ussullin, 11 Jul 2016, *C. W. Park & T. Y. Choi 23, 25–35* (SNU); Seonburyeong, 12 Jul 2016, *C. W. Park & T. Y. Choi 60–73* (SNU).

RUSSIA. Primorsky territory: Russia Island, 3 km to the north from Cape Vyatina, 15 Jul 2014, *C. W. Park & T. Y. Choi 32–40* (SNU); Between Olenevad and Tikhoye, 16 Jul 2014, *C. W. Park & T. Y. Choi 54, 55* (SNU).

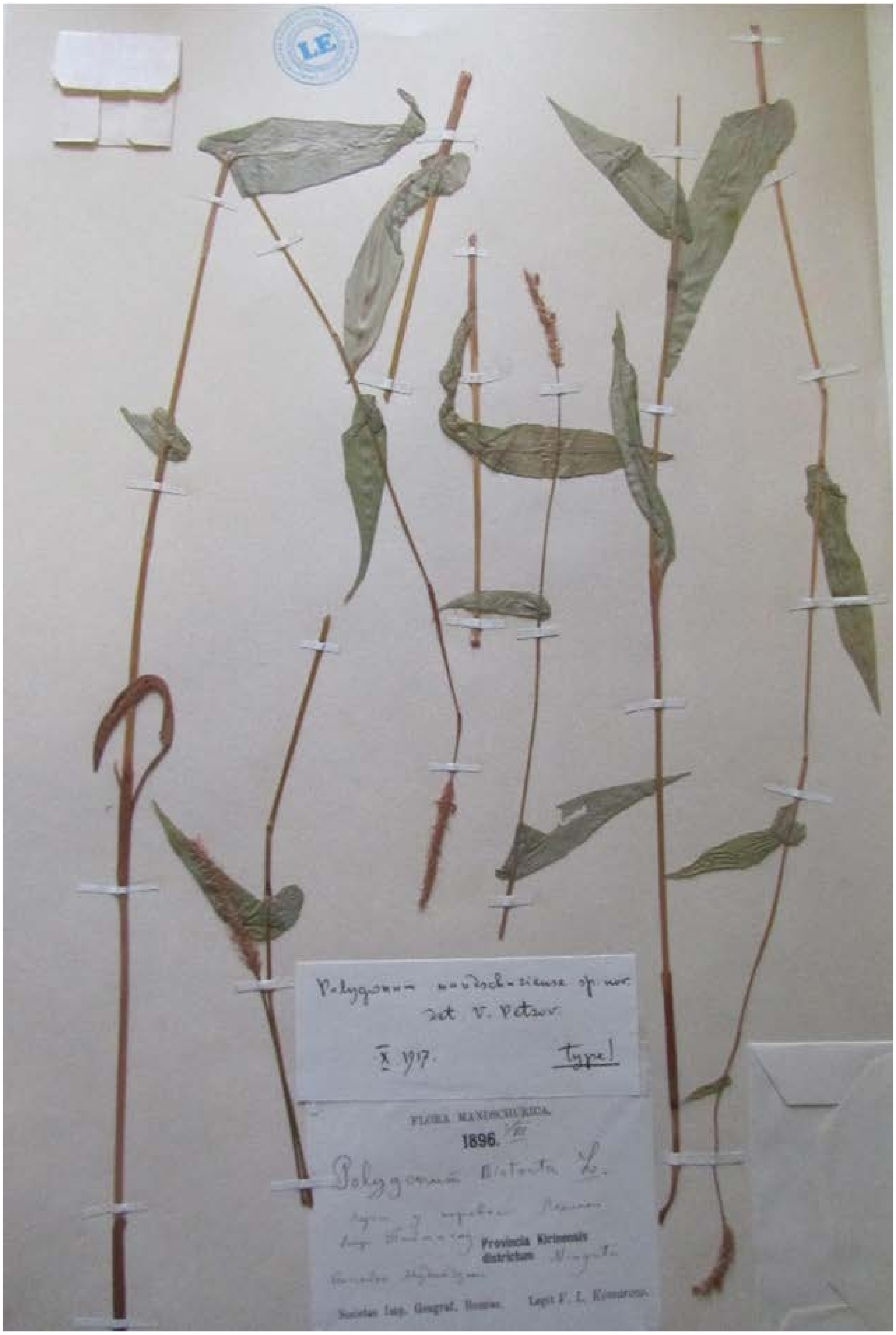

Fig. 18. Lectotype of *B. manshuriensis* (Petrov ex Kom.) Kom.

2. ***Bistorta officinalis*** Delarbre, Fl. Auvergne, ed. 2, 2: 516, 1800.

Polygonum bistorta L. Sp. Pl. 360, 1753. *Bistorta major* S. F. Gray, Nat. Arr. Brit. Pl. 2, 267, 1821. *Bistorta vulgaris* Hill, Brit. Herb. 488, pl. 70, fig. 10, 1756 (*nom. Illeg.*). Type: without specific locality and date, *Col?* (lectotype LINN 510.3).

Herbs 20–140 cm tall. Rhizomes 0.5–2 cm in diam. Stems usually 1–10. Leaves basal and cauline, glabrous to abaxially pubescent, membranous; basal leaves petiolate, blade lanceolate to ovate, 6–34 x 0.4–9.8 cm, acuminate at apex, base cuneate, truncate to subcordate, decurrent along petiole forming narrow or wide wings, petiole 3–48 cm long; lower cauline leaves lanceolate, base cuneate, upper ones subsessile, amplexicaul and auriculate or not amplexicaul, uppermost leaf lanceolate, linear to filiform; ocrea ciliate to eciliate. Inflorescences terminal, compact, 1.5–12.5 cm long, 0.6–1 cm in diam.; helicoid cymes 2–5-flowered, closely spaced; bracts oblong, ca. 4 mm long, membranous, cuspidate at apex. Flowers white; tepals elliptic, obtuse at apex; stamens exserted; style 3-cleft at base. Achenes ovate or orbicular in outline, slightly exserted, dark brown, shiny. Chromosome number $2n = 24, 48$.

1. Plants 75–140 cm tall, stems 1–5, basal leaves broadly lanceolate to ovate, base cuneate, truncate to subcordate ……..………… 2a. subsp. *japonica*
2. Plants 24.5–78 cm tall, stem 3–10, basal leaves lanceolate, base cuneate ………………………..……………….....…..….. 2b. subsp. *angustifolia*

2a. subsp. *japonica* (H. Hara) Yonek., Fl. Jap. (Iwatsuki et. al., eds.) 2a: 145, 2006.

Bistorta major var. *japonica* H. Hara, J. Fac. Sci. Univ. Tokyo, Sect. 3, Bot. 6: 35, 1952. *Polygonum bistorta* L. subsp. *japonicum* (H. Hara) T. Shimizu, New Alp. Fl. Jap. Col. 2: 357, 1983. Type: Honshu, Prov. Shimotsuke, Nikko, without date, *Matsumura s. n.* (holotype [not seen]).

Polygonum bistorta L. var. *angustifolium* Nakai, J. Coll. Sci. Imp. Univ. Tokyo 23: 13, 1908, not Meisn. (1856). Type: Korea. Kyong-geui: insula Shakuyaku circa Inchon, 31 Oct 1900, *T. Uchiyama s. n.* (holotype: TI [not seen]).

Bistorta vulgaris Hill var. *nitens* Nakai, Rigakkai 24: 295, 1926.

Korean Name: Beum-kko-ri (범꼬리)

Herbs 75–140 cm tall, rhizomes 0.8–2 cm in diam., blackish brown. Stems 1–5, unbranched. Leaves basal and cauline, usually membranous, glabrous or rarely abaxial surface hairy; basal leaves long petiolate, blade lanceolate to narrowly ovate, 12.5–34.1 x 1.7–9.8 cm wide, acuminate at apex, bases cuneate, truncate to subcordate, decurrent along petiole forming narrow or wide wings, entire at margin, revolute, veins may or may not be thickened at the margin, upper surface green, lower surface grayish green, petiole 17–48 cm long; cauline leaves lanceolate, upper ones sessile, amplexicaul, auriculate, base truncate to cordate, uppermost cauline leaf linear or filiform; ocrea cylindrical, 3–13.5 cm long, lower part green, upper part brown, membranous, oblique at apex, usually with short crispy hairs along the veins, often cleft to middle. Inflorescence terminal, compact, 3.5–11.8 cm long, ca. 1 cm in diam.; monochasia 1–5-flowered, closely spaced; bracts ovate, 3.5–4 mm long, membranous, cuspidate at apex; pedicels 4–5 mm long, articulate at apex. Flowers white; tepals elliptic, obtuse at apex, ca. 3 x 1.5 mm; stamens 8, exserted; filaments 3.5–4 mm long; style 3-cleft at base, exserted; stigmas 3, capitate. Achenes sharply trigonous, ovate in outline, 2.5–3.8 mm long, 1.5–2.5 mm wide, slightly exserted, dark brown, shiny. Chromosome number $2n = 24, 48$.

Flowering May to Aug.

Distribution: Japan, Korea.

Korea: All provinces except Jeju.

B. major var. *japonica* was reported in Korea by Lee (1996). In the present study, it was found that the Korean individuals identified as *B. manshuriensis* clearly differ from *B. manshuriensis* in having larger rhizome, presence of basal leaves, and distinctly thickened veinlets in the leaf margin. Korean individuals identified as *B. manshuriensis* are similar to *B. major* var. *japonica* in having glabrous, lanceolate or narrowly ovate basal leaves gradually tapering towards the apex. The results of the present study supported that *B. major* var. *japonica* is the part of the Korean flora (Lee, 1996).

Additional specimens examined: JAPAN. Hokkaido: Mt. Rausudake, Rauso-cho, Menashi-gun, 10 Aug 1974, *K. Tsuchiya 1102* (TI). Honshu: Nikko, 1931, *col.?* (TI); Nikko, 1 Aug 1877, *Col.?* (TI); Kyozan, 04 Oct 1879, *Col.?* (Type, TI 02733); Hiroshima, Shobara-shi, Kumano, at the summit of Mt. Ryu-o-zan, 11 Jul 2012, *Y. Kadota 123029* (TNS); Gifu, Sakauchi-mura, Ibi-gun, 8 Jun 1983, *H. Takahashi & H. Takano 7791* (TNS); Aomori, Nishitsugaru-gun, Iwasaki-mura, Mt. Mukaishirakamidake, 13 Jul 1975, *Ohba et al.* (TI). Kyushu: Ohita, Hokkein-onsen, northeast side of Mt. Kuju-san, Naoir-gun, 25 Jul 1970, *M. Shimizu & F. Maeda s. n.* (HUH).

KOREA. Hamnam: Usuryeong, 16 Aug 1935, *T. Nakai 15377* (TI [2 sheets]); on the way from Adeokryeong (Pyeongbuk) to (Jangjin) Hamnam, 6 Jul 1914, *T. Nakai s.n.* (TI). Gangwon-do: Pyeongchang-gun, Daegwanryeong-myeon, Mt. Odae, Jingogae, 19 Jun 2009, *G. S. Bhandari 101–116* (SNU); 7 Jun 2015, *H. J. Suh & G. S. Bhandari 1–4* (SNU); Mt. Odae, Jilmaenuf, 23 May 2015, *H. J. Suh 1–5* (SNU); 2 Jun 2015, *G. S. Bhandari 1562-1–1562-4* (SNU); 1 Jul 2016, *H. J. Suh & G. S. Bhandari 1671-52–1671-59* (SNU); Mt. Odae, Daegwanryeong, 7 Jun 2015, *H. J. Suh & G. S. Bhandari 11–15, 20–22* (SNU); Mt. Odae, Gyejangmaul, 7 Jun 15, *H. J. Suh & G. S. Bhandari 5–10, 23* (SNU); Yeongwol-gun, Yeongwol-eup, Yeongheung-ri, Mt. Bongnae, 6 Sep 2010, *G. H. Nam et al. SHY984* (KB); Yeongwol, Mt. Sambang, 9 Aug 2001, *W. T. Lee s. n.* (KNU); Bukryeong, Mt.

Chheongye, 7 Jul 1974, *W. T. Lee s. n.* (KNU); Chuncheon-si, Dongnae-myeon, Goeun-ri, Mt. Daeryeong, 10 Aug 1975, *W. T. Lee s. n.* (KNU [3 sheets]); 3 Sep 2011, *G. S. Bhandari & K. H. Kim 110903-51, 110903-52* (SNU). Gyeonggi-do: Pocheon-si, Naechon-myeon, Mt. Suwon, 17 Jul 2015, *G. S. Bhandari 150717-1–15717-7* (SNU); 11 Jul 2016, *G. S. Bhandari 16711-1, 2, 4, 10, 11, 13* (SNU); Gwangju-si, Namhansanseong, 15 Jul 2012, *G. S. Bhandari 120715-1,120715-2* (SNU), 24 Jul 2016, *G. S. Bhandari 16724-1*, *16724-2* (SNU), 4 Jul 1986, *Y. D. Kim s.n.* (SNU); Mt. Yongmun, 6 Jun 1972, *D. W. Lee s. n.* (SNU); Icheon-si, Baeksa-myeon, Songmal-ri, Wonjeokbong, 21 Jun 2007, *G. Y. Chung ANH-en-07621-004* (KB); Mt. Chheongye, 17 Sep 1977, *W. T. Lee s. n.* (KNU). Incheon: Jakyak-do, 31 Jul 1900, *Uchiyama s. n.* (TI [2 sheets]); 30 Oct 1900, *Uchiyama s. n.* (TI). Ganghwa-do, 10 Jun 1936, *Toh & Shim s. n.* (SNU 1449). Incheon: Ganghwa-gun, 10 Jun 1936, *Toh & Shim s.n.* (SNU 1449); Mt. Hyeolgu, 29 Jun 2007, *J. K. Eo & E. H. Lee s. n.* (KB); 1 Jul 11, *J. H. Park & K.-H. Kim 11071, 11072* (SNU). Gimpo-si, Yangchon-myeon, Masan-ri, Seogu, Mt. Gahyeon, 27 Jun 2010, *J.-H. Kim & I.-S. Yoon s. n.* (KB); 3 Aug 2014, *G. S. Bhandari 8031–8032* (SNU). Chungbuk: Jincheon, Mujaebong, 13 Jul 1988, *W. T. Lee s. n.* (KNU); Jincheon-gun, Chopyeong-myeon, Mt. Dootha, 26 Jul 2005, *G. E. Yoo s. n.* (KNU [2 sheets]); Cheongju-si, Sangtang-gu, Wolwudong, Mt. Seondo, 3 Aug 2009, *G. S. Bhandari 1051–1053* (SNU). Chungnam: Taean, Manripo, 13 Aug 1981, *Chung s.n.* (SNU); 11 Aug 2009, *G. S. Bhandari 1101–1111* (SNU)*;* Manripo, 13 Aug 1981, *Chung s.n.* (SNU); Hongseong-gun, Mt. Oseo, 31 May 1997, *S. K. Lee 20* (SNU); 10 Jul 2009, *G. S. Bhandari 801–816* (SNU); 3 Jul 2015, *G. S. Bhandari 1573-1–1573-13-4* (SNU). Seosan, Mt. Buchhun, 14 Jul 2015, *G. S. Bhandari 15714-1–15714-9*

(SNU); 16 Jul 2016, *H. J. Suh & G. S. Bhandari 1679-1–1679-3, 1679-7, 1679-8, 1679-11–1679-13* (SNU). Gwangju: Dong-gu, Jisan-dong, Mt. Mudeong, 5 Aug 2014, *G. S. Bhandari 8051–8058* (SNU). Daegu: Salseong-gun, Mt. Biseul, 6 Jul 2000, *M. H. Kim 580–600* (SNU); 26 Jul 2009, *G. S. Bhandari 1001–1017* (SNU); 28 Sep 2014, *J. H. Park 1* (SNU). Gyeongbuk: Chilgok-gun; Gyeongnam, Milyang-si, Mt. Jongnam, south facing slope, 7 Jun 2008, *Won 622, 625*; 27 Jun 2009, *G. S. Bhandari 630–636* (SNU); Chilgok-gun, Gasanmyeon, Gasan-ri, Gasansanseong, 22 Jul 2014, *G. S. Bhandari 7771–7777* (SNU), *Won 342* (SNU). Gyeongnam: Wiryeong-gun, Garaemyeon, Mt. Jagul, 23 Jul 2014, *G. S. Bhandari 7751–7763* (SNU); 6 Aug 2000, *T. K. Hwan s. n.* (KB); 28 Jul 2002, *J. H. Kim & S. H. Park s. n.* (KB); Mt. Mitha, 9 Jul 2012, *G. S. Bhandari 120709-14–120709-21* (SNU); 29 May 2007, *C. S. Lee et al. A1* (KB); Changwon-si, Wichang-gu, between Mt. Bulmo and Mt. Woong, 6 Jun 2008, *Won 579, 580* (SNU); 14 Aug 2010, *J. H. Park & G. S. Bhandari 5581–5592* (SNU); 8 Aug 1977, *W. T. Lee s. n.* (KNU [2 sheets]); Geoje-si, Mt. Noja, 23 May 2008, *G. S. Bhandari 601* (SNU); on the way between Mt. Noja and Mt. Gara, 24 May 2008, *G. S. Bhandari 602–606* (SNU). Jeonbuk: Jangsu-gun, Gyenam-myeon, Mt. Jangan, 19 Jun 2009, *J. K. Ahn et. al.* (KB); Muju-gun, Jeoksang-myeon, Bukchang-ri, Mt. Jeoksang, 29 Jul 2009, *H. J. Kim s. n.* (KB). Jeonnam: Yeosu-si Dolsan-do, Bongnim–Mt.Bonghwang–Yullimchi, 5 Aug 2003, *S. G. Kwon & W. H. Kim s. n.* (KB); Damyang-gun, Mt. Byeongfung, 11 Jul 2014, *G. S. Bhandari 7721–7723, 7731–7732, 7741, 7742, 7745–7748* (SNU); Wando, Mt. Sammun, 16 Jul 2014, *G. S. Bhandari 7015–7017* (SNU); Haenam-gun, Mt. Duryun, 15 Jul 2014, *G. S. Bhandari 7020–7024, 7026–7035* (SNU).

RUSSIA. Primorsky territory: Khankisky District, vicinities of Komissarovo sattlement, on the mix meadow, Loc 2, 3 Jul 2015, *C. W. Park et al. 57–73, 75–76, 79–95, 97–104, 112–118* (SNU).

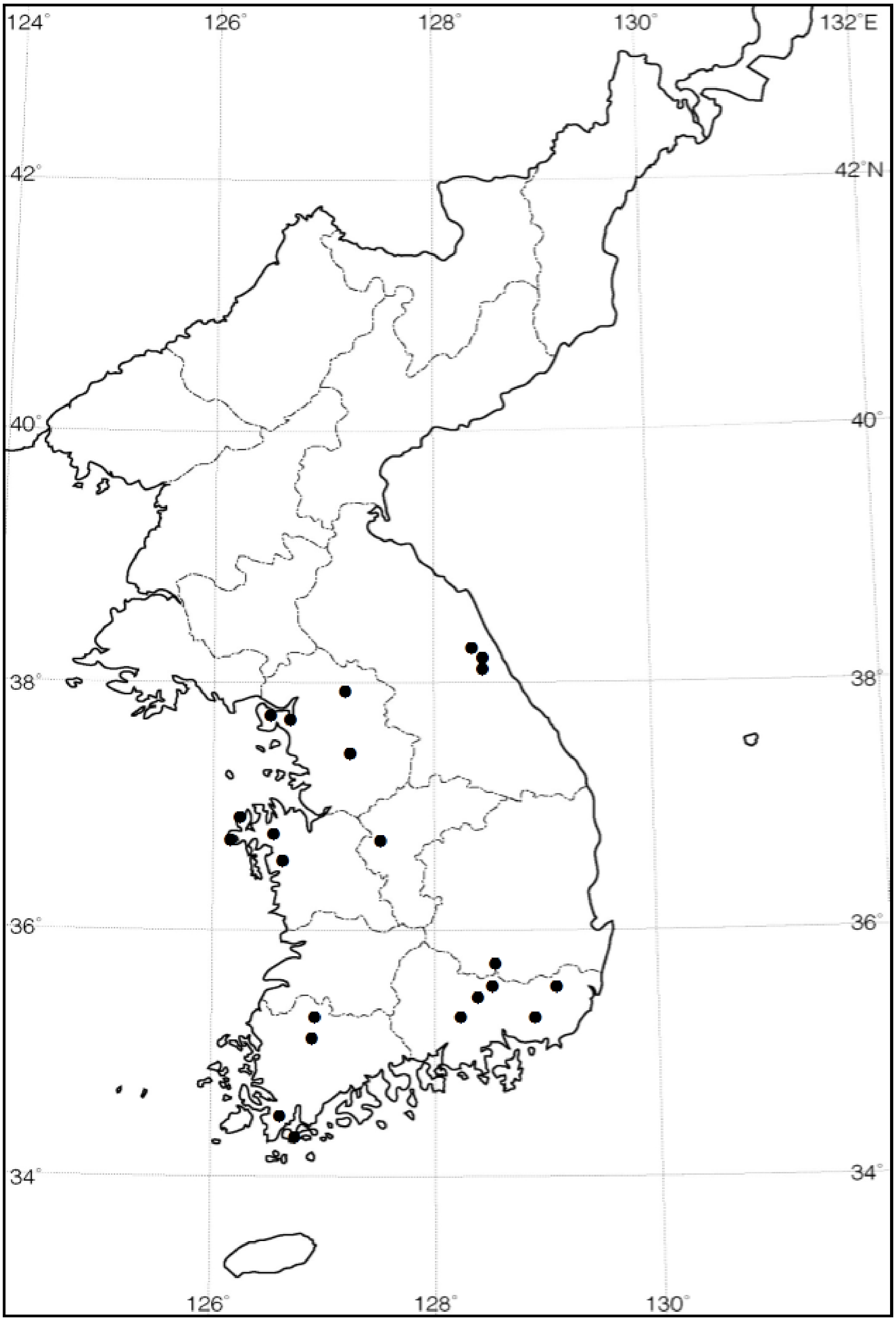

Fig. 19. Distribution of *B. officinalis* subsp. *japonica* in Korea

Fig. 20. Type specimen of *B. major* var. *japonica* (Nakai) H. Hara.

2b. subsp. *angustifolia* (Hayne) C. W. Park comb. nov.

Polygonum bistorta var. *angustifolium* Hayne, Getreue Darstell. Gew. 5: 19, 1817, not Meisn. (1856). *Bistorta vulgaris* Hill var. *angustifolia* (Hayne) H. Gross, Bull. Géogr. Bot. 23: 17, 1913. – Type: not cited.

Korean name: Ga-Neun-Beum-kko-ri (가는범꼬리)

Herbs 20–78 cm tall. Rhizome 0.5–1.2 cm in diam. Stems 3–10, erect, 1–2 mm in diam., herbaceous. Leaves: basal leaves membranous or slightly coriaceous, lanceolate, upper surface green and lower surface grayish green, 8.4–21.8 x 0.6–3.6 cm, bases cuneate, decurrent along petiole, revolute with thickened veins at margin, petiole 3–26 cm long, narrowly winged; lower cauline leaves petiolate, blade lanceolate, base cuneate; middle and upper cauline leaves subsessile, not amplexicaul, cuneate or truncate at base, uppermost cauline leaves linear, ocreae 2–7 cm long. Inflorescences terminal, straight or curved, lax or densely flowered, 1.7–7.1 cm long, ca. 0.6 cm in diam.; monochasia 2–3-flowered; bracts ovate to lanceolate, ca. 3.5–4.5 mm long, awnless or with short awn at apex; pedicels ca. 4 mm long, longer than bracts. Flowers white to pinkish white; tepals narrowly elliptic, sometimes broadly ovate, 1.8–3.2 mm long, acute to obtuse at apex; stamens exserted; filaments 1–3.5 mm long, slender; style 1–3 mm long. Achenes orbicular, sharply trigonous, 2.8–3 x 1.7–2.2 mm, slightly exserted, brown, shiny. Chromosome number: $2n = 24$.

Flowering Jul to Sep.

Distribution: Korea (Mt. Halla).

Bistorta alopecuroides was first reported in Korea (Mt. Halla) by Nakai (1938), who was followed by subsequent Korean taxonomists (Park, 1974; Lee, 1980; Lee, 1996; Park and Hong, 2007). Lee (1996), however, reported *Bistorta major* var. *angustifolia* from Mt. Halla, and Yonekura (2006) identified these individuals as *Bistorta officinalis* subsp. *japonica*. Based on field collections of *B. alopecuroides* from Mongolia and Mt. Halla of Jejudo, and comparison with the type specimens deposited at LE, the individuals of Mt. Halla were found to differ remarkably from *B. alopecuroides* in several characteristics such as plant height, stem diameter, shape and size of basal and cauline leaves and inflorescence length. Moreover, the chromosome counts showed that the individuals of Mt. Halla were diploids ($2n = 24$), in contrast to tetraploid ($2n = 48$) individuals of *B. alopecuroides*. Based on these results, the individuals of Mt. Halla are identified as *B. officinalis* subsp. *angustifolia* in this study.

Additional specimens examined. KOREA. Jejudo: Mt. Halla, 16 jul 1991, *W. G. Baek et al. s. n.* (KNU [2 sheets]); Yeongsil course, 15 Jul 2010, *H. Won & G. S. Bhandari 3051–3069* (SNU); Yeongsil course, 26 Jul 2007, *G. S. Bhandari 308, 310–315* (SNU); 9 May 2008, *G. S. Bhandari 3365, 3372* (SNU); near Witseoreum shelter, 15 Jul 2010, *G. S. Bhandari 3070–3074* (SNU); Mt. Halla, Witseoreum shelter, 15 Jul 2010, *G. S. Bhandari 3075–3076* (SNU); 4 Sep 2014, *C.-S. Kim*

0904-1–0904-7 (SNU); Witseoreum-Oerimok, 15 Jul 2010, *G. S. Bhandari & K.-H. Kim 3077–3080* (SNU); Gwaneumsa course, 16 Jul 2010, *G. S. Bhandari & K.-H. Kim 3101–3114* (SNU); Gwaneumsa course, 16 Jul 2010, *G. S. Bhandari 3114* (SNU); 26 Jul 2007, *G. S. Bhandari 330, 341, 3300* (SNU); 1 Aug 2008, *G. S. Bhandari & Y. Gao 3001–3007*; Baekrokdam, 26 Jul 2007, *H. Won & G. S. Bhandari B1–B7* (SNU); Seongfanak course, 1 Aug 2008, *G. S. Bhandari & Y. Gao 3011–3017* (SNU); Gwaneumsa-Yongingak shelter, 8 Jul 2008, *B. Y. Lee & S. G. Kwon s. n.* (KB).

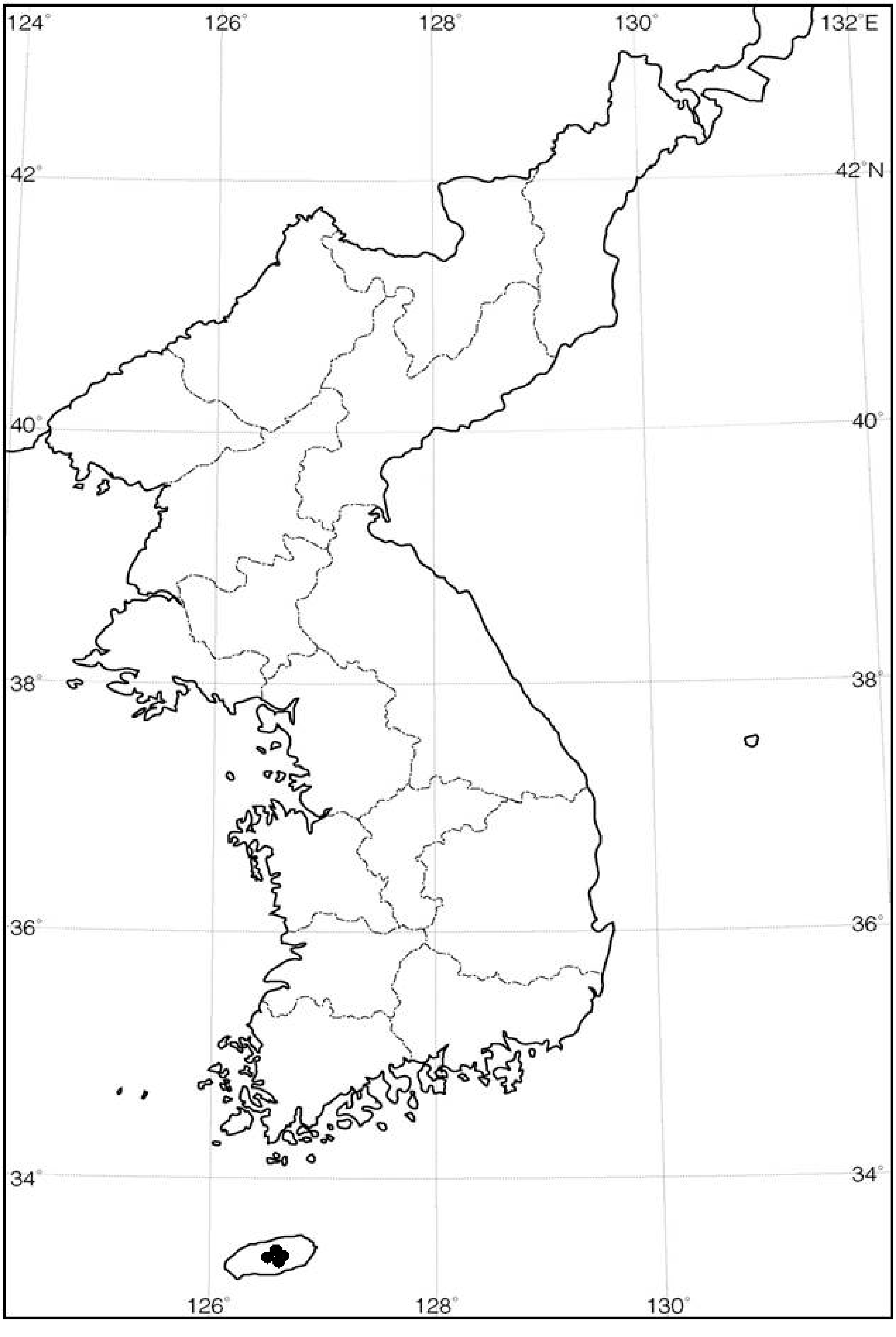

Fig. 21. Distribution of *B. officinalis* subsp. *angustifolia* in Korea.

3. **_Bistorta pacifica_** (Petrov ex Kom.) Kom. ex Nakai, J. Jap. Bot. 14: 1938.

Polygonum pacificum Petrov ex Kom., Bot. Mater. Gerb. Glavn. Bot. Sada S.S.S.R. 6: 2, 1926. *Bistorta vulgaris* Hill var. *pacifica* (Petrov ex Kom.) Miyabe in Miyabe & Kudo, J. Fac. Agric. Hokkaido Imp. Univ. 26: 508, 1934. *Bistorta major* Gray var. *pacifica* (Petrov ex Kom.) H. Hara, J. Jap. Bot. 13: 382, 1937. *Polygonum bistorta* L. subsp. *pacificum* (Petrov ex Kom.) Vorosch., in A. K. Skvortsov, Florist. Issl. v Razn. Raionakh SSSR 163, 1985. *Bistorta officinalis* Delarbre subsp. *pacifica* (Petrov ex Kom.) Yonek., Fl. Jap. (Iwatsuki et al., eds.) 2a: 144, 2006. Type: Russia. Far East: "sinus America, pagum Americanka, in valle supra lacum putridum, pratincolae silvaticae ad ripas rivuli, sparse, deflorens", 29 Aug 1913, *Komarov 1204* (lectotype: LE [not seen]); "insula Putjatin, in fruticetis ad cacumen montis, ad florendi initium", 19 Jun 1913, *A. Bulavkina 200* (syntype: LE [not seen]); "in valle fl. Suifun, in vicinitate pag. Rasdolnoje, in declilivio herboso, in pleno anthesi", 30 Jun 1913, *N. V. Schipczinskij 280* (syntype: LE [not seen]).

Bistorta vulgaris Hill var. *ovata* Nakai ex H. Hara, Bot. Mag. (Tokyo) 48: 890, 1934. *Bistorta major* Gray var. *ovata* (Nakai ex H. Hara) H. Hara, J. Jap. Bot. 13: 382, 1937. *Bistorta vulgaris* Hill var. *nitens* (Fisch. & C. A. Mey.) Nakai, Miyabe & Kudo, J. Fac. Agric. Hokkaido Imp. Univ. 26(4): 508, 1934, not Nakai (1926). Type: Japan. Yezo: prov. Ishikari, Mt. Yubari, Aug 1916, *G.*

Koidzumi s. n. (holotype: TI [not seen]); Mt. Daisetsu, Aug 1928, *T. Nakai s.n.* (paratype: TI [not seen]).

Polygonum bistorta var. *ussuriense* Regel, 1861; *P. ussuriense* (Regel) Petrov ex Kom., 1926. *Bistorta ussuriensis* (Regel) Kom., 1926 (pro syn.). Type: Russia. “Ussuri dec. med. Promontorium Chat, fl.”, 1859, *R. Maak s. n.* (lectotype: LE [not seen]); “id. Ostium affluentis Tschirku, fl.”, without specific date, *R. Maak s. n.* (syntype: LE [not seen]).

Korean name: Cham-beom-kko-ri (참범꼬리)

Herbs 40–110 cm tall. Rhizomes 1.5–3 cm in diam., blackish brown. Stems 2–4, erect. Leaves basal and cauline, membranous to coriaceous; basal leaf blade narrowly to widely ovate, undulate, 5–17.8 x 3–9.6 cm, acute at apex, bases subcordate or cordate, decurrent along petiole, forming narrow or sometimes wide wings, upper surface green, lower surface grayish green, glabrous or lower surface sparsely or densely pubescent with white hairs, usually prominent leaf veins on the lower leaf surface, margin slightly revolute, basal leaves long petiolate; petiole 8–38 cm long; lower cauline leaves ovate or lanceolate-ovate, bases cordate, petiolate, middle and upper cauline leaves ovate to lanceolate, sessile, amplexicaul, uppermost cauline leaf narrowly lanceolate to filiform; ocrea 3–7 cm long, membranous, glabrous or hairy, lacerate at upper part. Inflorescences terminal, compact, 3–5.7 cm long, 1.2–1.5 cm in diam.; monochasia 1–3-flowered, closely spaced; bracts broadly elliptic to ovate, 3–4 mm long, caudate at apex; pedicels 4–5 mm long, longer than bracts, slender. Flowers white or pinkish, perianth ca. 2.5–3.2 mm long; tepals elliptic to oblong, obtuse at apex; stamens exserted; filaments 2–5 mm long, 1.5–3 mm long. Achenes sharply trigonous, ovate in outline, ca. 3.3–4 x 2–2.7 mm, slightly exserted, black-brown, shiny. Chromosome number $2n = 48$.

Flowering Jun to Aug.

Distribution: NE China, Korea, Russian Far East.

Korea: North Korea, Gangwon, Gyeongnam.

Bistorta pacifica was first reported in Korea by Nakai (1938). He was followed by subsequent Korean authors (Park, 1974; Lee, 1980; Lee, 1996; Lee, 1996; Park & Hong, 2007). One closely related taxon, *Bistorta major* var. *ovata* Nakai ex H. Hara, was reported from Japan by Nakai (1926). This taxon is similar to *B. pacifica* in having thick tortuous rhizome, ovate basal leaf with cordate base and prominent leaf veins on abaxial surface. Chromosome counts in the present study revealed that both taxa have identical chromosome numbers ($2n = 48$). Moreover, phylogenetic analyses based on cpDNA sequence data showed that the individuals of *B. major* var. *ovata* collected from type locality from Japan formed a clade with the individuals of *B. pacifica* from Russia (locus classicus). Based on these results, *B. major* var. *ovata* is transferred to *B. pacifca* in this study.

Additional specimens examined: CHINA. Jilin: Tumen-si, Janganjin (Chang'anzhen), Mt. Yasan, 23 Jul 2014, *T. Y. Choi 3–13* (SNU).

JAPAN. Hokkaido: Yezo, Rishiri, 06 Jul 1914, *Tamaki s. n.* (TI 2690); 11 Aug 1921, *Col?* (TI 2696); 06 Sep 1926, *Kando s. n.* (TI 7610); Sohya, Mt. Rishiri in Rishiri Isl., 15 Aug 1984, *T. Kato & S. Sakai 4197* (TI); Mt. Rishiri, 6 Jul 1914, *col.?* (TI) Yezo, Rebun-do, 10 Jul 1914, *Tamaki s.n.* (TI); Mt. Yubari, 08 Aug 1913, *S. Tamaki s. n.* (TI); Mt. Yubari, Kanayamaguchi, 21 Jul 1933, *H. Hara s. n.* (TI); Sapporo, Aug 1928, *T. Nakai 2748, 2749* (TI); Mt. Obira, Shimamaki, Shimamaki District, Hokkaido, 25 Jul 2014, *H.-M. Kim 28–32* (SNU); Rebun Island, 21 Jun 2016, *H.-J. Suh 1–5* (SNU); near Momoiwa in Rebun Island, 1952, *M. Hiroe 7602* (TI); Rebun Isl., 10 Jul 1914, *Col.?* (TI); Oshima-shicho, Matsumae-gun, Fukushima-cho, Mt. Daisengendake, 24 Jul 1977, *K. Takeda s. n.* (TI [2 sheets]); Shiribeshi, Shiribeshi-gun, Shimamaki-mura, Mt. Ohira-yama, 5 Aug, 1983, *H. Takahashi et al. 79* (TI). Honshu: Niigata, Mts. Iide, in between Mt. Eburisashidake & Mt. Ohishi-yama, 10 Aug 1982, *Y. Tateishi et al. 8889* (TI); Iwate, Ushigata-yama, 20 Jul 1962, *M. Takahashi s. n.* (TI)

KOREA. Hamnam: Hamjiwon, 16 Jul 1934, *Toh & Shim s. n.* (SNU 1458, 1459); Bujeon Plateau, 20 Jul 1938, *Toh & Shim s. n.* (SNU 1457); Pyeong-buk: Mt. Myohyang, 20 Jul 1938, *Toh & Shim s. n.* (SNU); Yanggang: Mt. Baekdu, Aug 1990, *Yoon s. n.* (SNU). Hwanghaenam: Jangsangot, 4 Aug 1930, *Nakai s. n.* (SNU 1450). Gyeonggi-do: Gapyeong-gun, Buk-myeon, Mt. Hwa-ak, 26 Jun 2008, *G. S. Bhandari 201–208* (SNU). Gangwon-do: Inje-gun, Wolhak-ri, Mt. Daeam, 7 Jul 1995, *W. T. Lee s. n.* (KNU [2 sheets]); 26 Jul 1988, *W. T. Lee s. n.* (KNU); 28 Jul 1988, *W. T. Lee s .n.* (KNU); Youngneof, 22 Jun 2000, *K. C. Yang & J. D. Jung s. n.*

(KB); 4 Jul 1967, *Jeong & An s. n.* (SNU); 13 Jul 1967, *Chung s.n.* (SNU [5 sheets]); 5 Oct 1972, *Jeong & An s. n.* (SNU); 23 Aug 2014, *H. J. Suh & G. S. Bhandari 823-1–823-12* (SNU); 4 Aug 2015, *H. J. Suh 1584-1–1584-7* (SNU); 26 Jun 2016, *H. J. Suh & G. S. Bhandari 16626-01–16626-07, 16626-15–16626-22* (SNU); Inje-gun, Sangnam-myeon, Misan-ri, Mt. Bangtae, 18 Jul 2007, *Y. D. Kim & S. H. Cho s. n.* (KB); Mt. Myeon, 10 Jun 1990, *S. H. Oh s. n.* (SNU); Pyeongchang-gun, Mt. Cheongok, 26 Jun 2000, *W. T. Lee s. n.* (KNU [2 sheets]); *H. J. Suh & G. S. Bhandari 16630-22–16630-26, 16630-31* (SNU); *G. S. Bhandari 1401–1417* (SNU); 14 Jun 2008, *S.-J. Lee 650* (SNU); Pyeongchang-gun, Hwaryeongbong, 21 Jun 1998, *W. T. Lee s. n.* (KNU); Bongpyeong-myeon, Mui-ri, Mt. Taegi, 27 Jul 1976, *W. T. Lee s. n.* (KNU); 17 Jun 1990, *W. T. Lee s. n.* (KNU); 8 Aug 2009, *S. C. Ko & D. C. Son s. n.* (KB); 25 Jun 2010; Hongseong-gun, Dunnaemyeon, Mt. Taegi; *H. J. Suh & G. S. Bhandari 16630-27–30* (SNU); Samcheok, Mt. Daeseong, 25 May 1983, *W. T. Lee s. n.* (KNU); Samcheok-si, Singi-myeon, Daeri-ri, Mt. Deokhang, 7 Jul 2006, *C. S. Lee et al. LEECS070693* (KB) ; Jeongseon-gun, Mt. Gariwang, 16 Jun 1996, *W. T. Lee s. n.* (KNU); 25 Jun 2009, *G. S. Bhandari 151–157, 159–169, 171–173* (SNU)*;* Taebaek-si, Geumdaebong, 30 Jun 2009, *C. S. Lee et al. 090570* (KB); Taebaek-si, Mt. Daetak, 13 Aug 2004, *G. E. Yoo s. n.* (KNU [2 sheets]); Mt. Hambaek Pop1, 30 Jul 2014, *G. S. Bhandari 7075, 7077–7080* (SNU); Pop2, 30 Jul 2014, *G. S. Bhandari 7081–7091* (SNU); Jeongseon-gun, Gohan-eup, Gohan-ri, Mt. Hambaek, 8 Jul 2009, *S. C. Ko & D. C. Son HNHM-1916, HNHM-1919.* (KB); Gohan-ri, Geumdae-bong *G. S. Bhandari 1225* (SNU); 30 Jul 2014, *G. S. Bhandari 7092, 7093* (SNU); Taebaek-si, Mt. Taebaek, 15 Jul 1996, *J. Song 00137* (SNU); 15 Jul 2008, *G. S. Bhandari*

701–705 (SNU)*;* 23 Jul 1986, *W. T. Lee s. n.* (KNU); Hongcheon-gun, Naemyeon, Mt. Gyebang, 24 Jul 2012, *G. S. Bhandari 2012724-1–12* (SNU); 16 Jun 1993, *G. E. Yoo & W. T. Lee s. n.* (KNU [2 sheets]); Hongcheon-gun, Jaun-ri, 1150, 1 Jul 2015, *H. J. Suh 1571-1* (SNU); Jeongseon-gun, Gohan-ri 216-1, Manhangje, *H. J. Suh & G. S. Bhandari 16630-34–16630-39* (SNU); 5 Jul 2015, *H. J. Suh 1575-1–1575-7* (SNU); *H. J. Suh & G. S. Bhandari 16630-1–6, 16630-32, 16630-33, 16630-40* (SNU); Wonju-si, Mt. Chiak, 22 Jul 2006, *G. E. Yoo s. n.* (KNU). Chungbuk: Yeongdong-gun, Mt. Minjuji, 11 Aug 1976, W. T. Lee (KNU); 10 Jul 2010, *G. S. Bhandari 1501–1512, 1515* (SNU); 24 Aug 2014, *J. H. Park 1* (SNU). Gyeongbuk: Yeongjusi, Punggi-ub, Sucheol-ri, Sobaeksan, abt. 50 m below the peak (1383 m); near Astronomical Observatory, 7 Jul 2007, *G. S. Bhandari 2, 4, 9, 15, 51–53, 55–59* (SNU); Yeongjusi, Punggi-ub, Sucheol-ri, Mt. Sobaek, Yeonghwa-bong, 7 Jul 2007, *G. S. Bhandari 6, 40* (SNU); Yeongyang-gun, Ilwol-myeon, Mt. Ilwol, 29 Jul 11, *G. S. Bhandari 11726-1–3, 11726-7–9* (SNU); Bonghwa-gun, Seokpo-myeon, Seokpo-ri, Duribong, 5 Jul 2008, *G. Y. Chung ANH-en-080705-044* (KB); 5 Jul 2008, *G. Y. Chung & M.-S. Park s. n.* (KB). Gyeongnam: Sancheong-gun, Jungsan-ri, Mt. Jiri, Jangthmok shelter, 6 Aug 2007, *G. S. Bhandari 501–503, 505, 507, 509–510, 512–518* (SNU); 6 Aug 2007, *G. S. Bhandari 521* (SNU); Saeseok shelter, 6 Aug 2007, *G. S. Bhandari 532, 535, 536* (SNU); Sancheong-gun, Sicheon-myeon, Sa-ri, Mt. Jiri, Banyabong, 3 Jun 2002, *C. H. Kim et al. s. n.* (KB); Wangdeong wetland, 1 Jul 2010, *G. S. Bhandari 551, 551-1, 552, 553-1, 553-2, 554-1, 554-2* (SNU); near Hyeongje-bong, 21 Jul 2000, *M.-H. Kim 664–668* (SNU); Mt. Jiri, 17 Aug 1978, *W. T. Lee s. n.* (KNU). Jeonbuk: Muju-gun, Mt. Deokyu, 15 Jul 2011, *G. S. Bhandari 11101–11108* (SNU). Jeonnam:

Mt. Jiri, Dwajipyeongjeon, 20 Jul 2000, *M. H. Kim 650–653* (SNU); Mt. Jir, near Tokki-bong, 20 Jul 2000, *M. H. Kim 655–663* (SNU).

RUSSIA. Primorsky territory: Shkotovsky District, vicinities of Nahodka city, near Griloye Lake, 1 Jul 2015, *C. W. Park et al. 10–14, 16–19* (SNU); west border of Ussuriysky Preserve, 17 Jul 2014, *C. W. Park & T. Y. Choi 107, 108* (SNU); Sakhalin: Isl. Kaiba, 18 Jul 1929, *S. Saito s. n.* (TI).

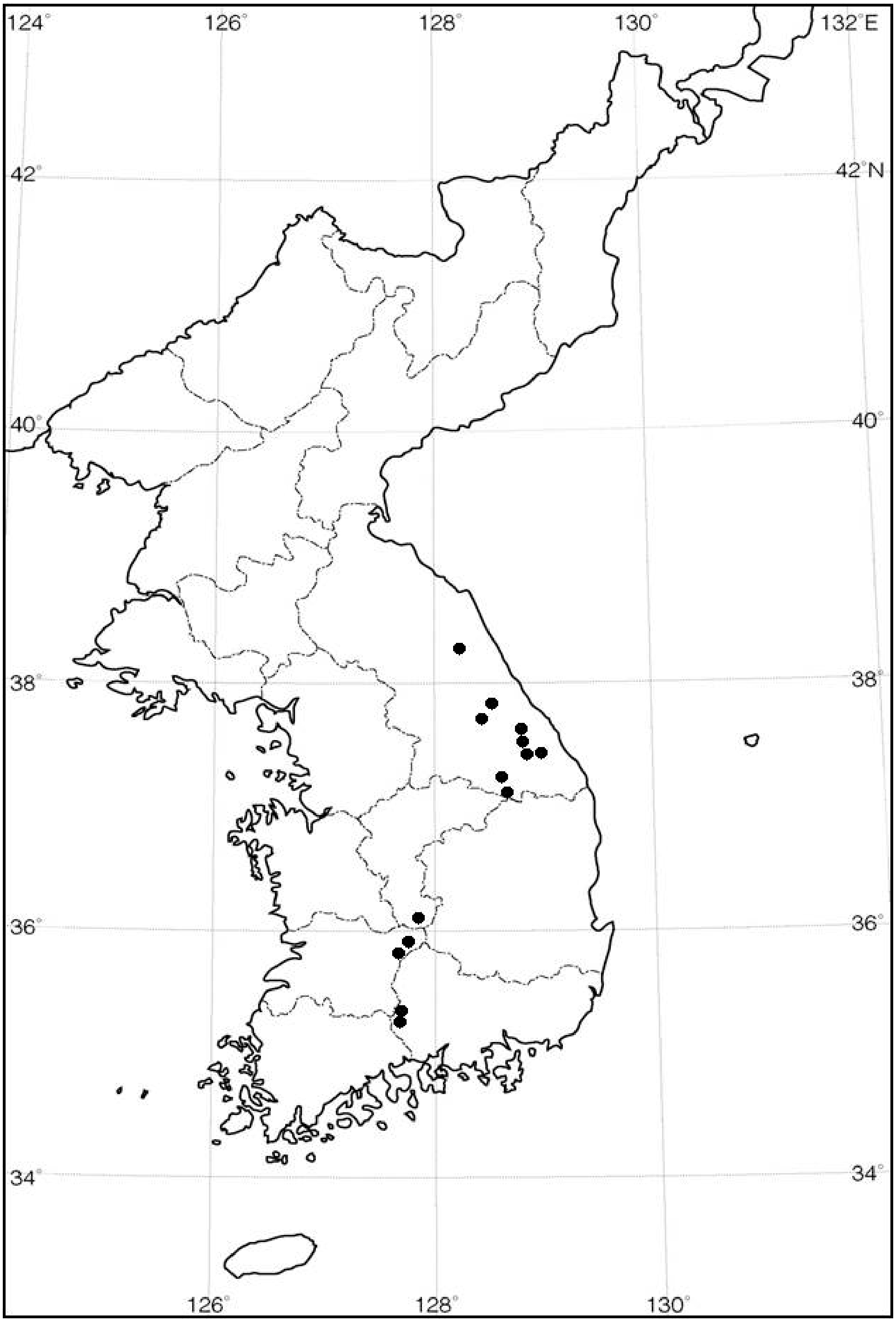

Fig. 22. Distribution of *B. pacifica* in Korea.

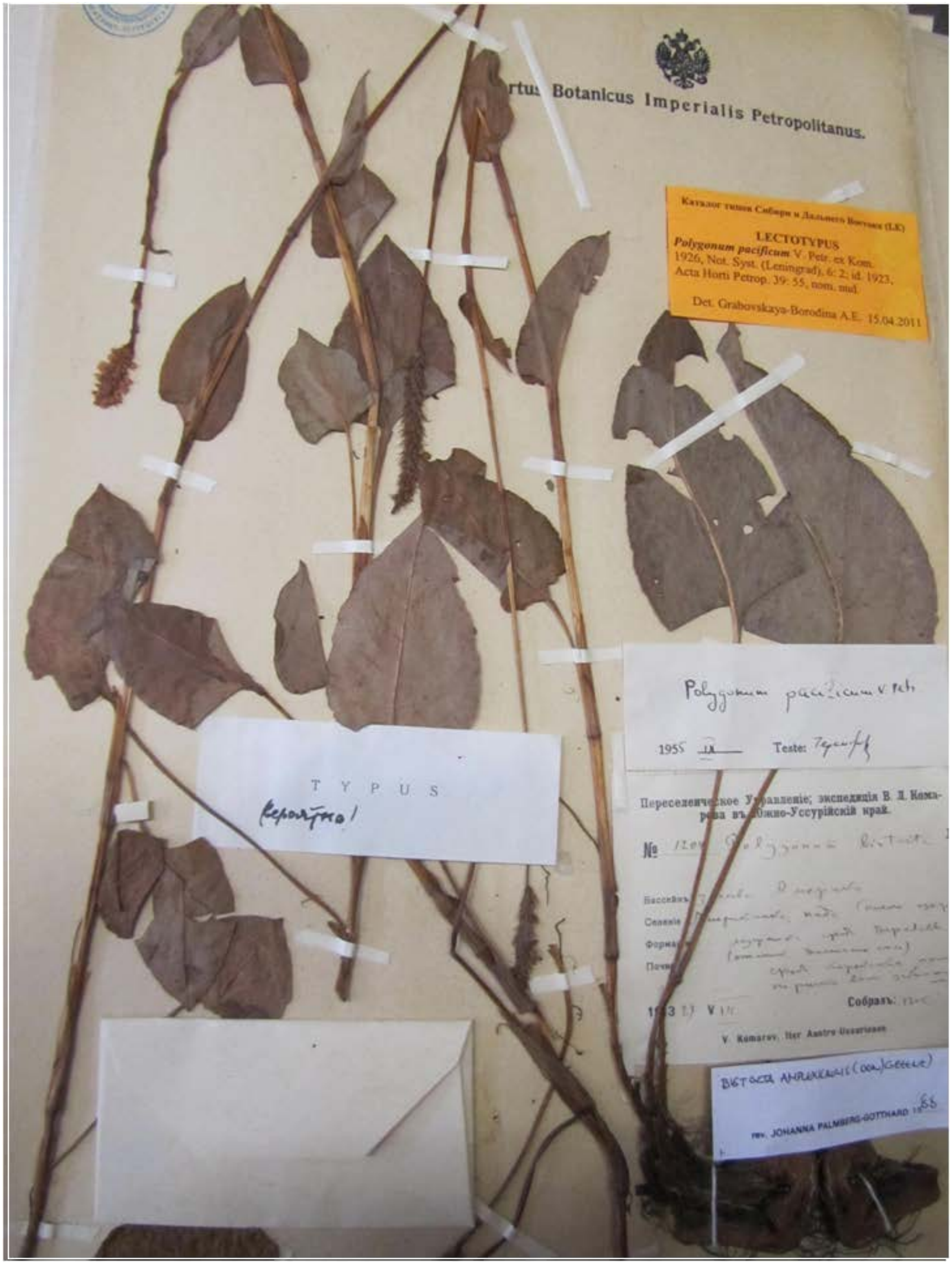

Fig. 23. Lectotype of *B. pacifica* (Petrov ex Kom.) Kom. ex Nakai

Fig. 24. Holotype of *B. major* var. *ovata* (Nakai ex H. Hara) H. Hara.

4. ***Bistorta koreana*** C. W. Park & G. S. Bhandari sp. nov.

Type: Korea. Gangwon-do, Inje-gun, Buk-myeon, Mt. Seorak, Daecheongbong, N38°07’ 08.88” E128° 27’ 54.98”, 1693 m, 21 Jun 2016, *G. S. Bhandari 16621-1* (holotype, SNU).

Korean name: Seol-ak-beom-kko-ri (설악범꼬리)

Herbs 49.5–71 cm tall. Rhizomes 0.6–1.1 cm in diam., tortuous, light brown. Stems 2–7, erect, ca. 4 mm thick, pale green. Leaves basal and cauline, coriaceous, both surfaces glabrous; upper surface dark green, lower surface pale green, basal leaves petiolate, leaf blade narrowly ovate to lanceolate-elliptic, 9–19.3 x 3.8–8.6 cm, acuminate at apex, bases cordate to subcordate, decurrent along petiole forming narrow wings or wings nearly absent, margin weakly reovolute, undulate; petiole 16.4–50.6 cm, narrowly winged at the junction with the leaf blade; cauline leaves lanceolate, lower 1–2 cauline leaves petiolate, middle and upper ones sessile, base cordate, amplexicaul, auriculate base, middle leaves usually strongly undulate and curved, upper penultimate leaf linear, uppermost leaf linear or filiform; ocrea 3.2–10.8 cm long, membranous, eciliate or sometimes ciliate. Inflorescences terminal, rarely terminal and axillary, compact, 2–7 cm long, ca. 1.5 cm in diam.; monochasia 2- to 3-flowered, closely spaced; bracts obovate to lanceolate, ca. 3 mm long, membranous, cuspidate at apex. Flowers pinkish or white; tepals elliptic to oblong, ca. 3 mm long, obtuse at apex; stamens exserted;

filaments 3.5–4 mm long, anthers dark purple; style 3-cleft at base, exserted. Achenes ellipsoid in outline, 3.2–4 x 1.8–2.1 mm wide, enclosed, dark brown, shiny. Chromosome number $2n = 24$.

Flowering May to Jun.

Distribution: *B. koreana* is only found on Mt. Seorak of Korea, where it grows in open area on top of the mountain.

Etymology: The species epithet denotes the fact that the species is so far known only known from Korea.

This taxon resembles to *Bistorta pacifica* in having cordate leaf base, weakly winged petiole and thick inflorescence (Komarov, 1936; Nakai, 1938). *Bistorta koreana*, however, differs from *B. pacifica* in having shorter stature, relatively narrow lamina of basal leaves, curved middle leaf with undulate margin and presence of second linear cauline leaf from the top. DNA sequence data revealed that these plants do not contain the general ribotype R1 that was found in nearly all individuals of all taxa of the *B. manshuriensis* complex suggesting their different evolutionary history. Moreover, the individuals of *B. koreana* is diploid ($2n = 24$) compared to tetraploid ($2n = 48$) *B. pacifica*. Based on morphological, chromosomal and molecular data, a new species, endemic to Korea, is proposed in this study.

Additional specimens examined: KOREA. Gangwon-do, Inje-gun, Mt. Seorak, 26 Jul 1996, *W. T. Lee s. n.* (KNU); 16 Jun 1977, *B. G. Yoon s. n.* (KNU); 17 Jun 1977, *B. G. Yoon s. n.* (KNU); 11 Jul 1977, *B. G. Yoon s. n.* (KNU); 12 Aug 2001, *M. H. Kim 735, 742, 745* (SNU); 20 Jul 2007, *H. Won & G. S. Bhandari 401–405* (SNU); 28 Aug 2013, *T. Y. Choi 1* (SNU); 16 Jun 2016, *G. S. Bhandari 16621-1–9, 11–17* (SNU).

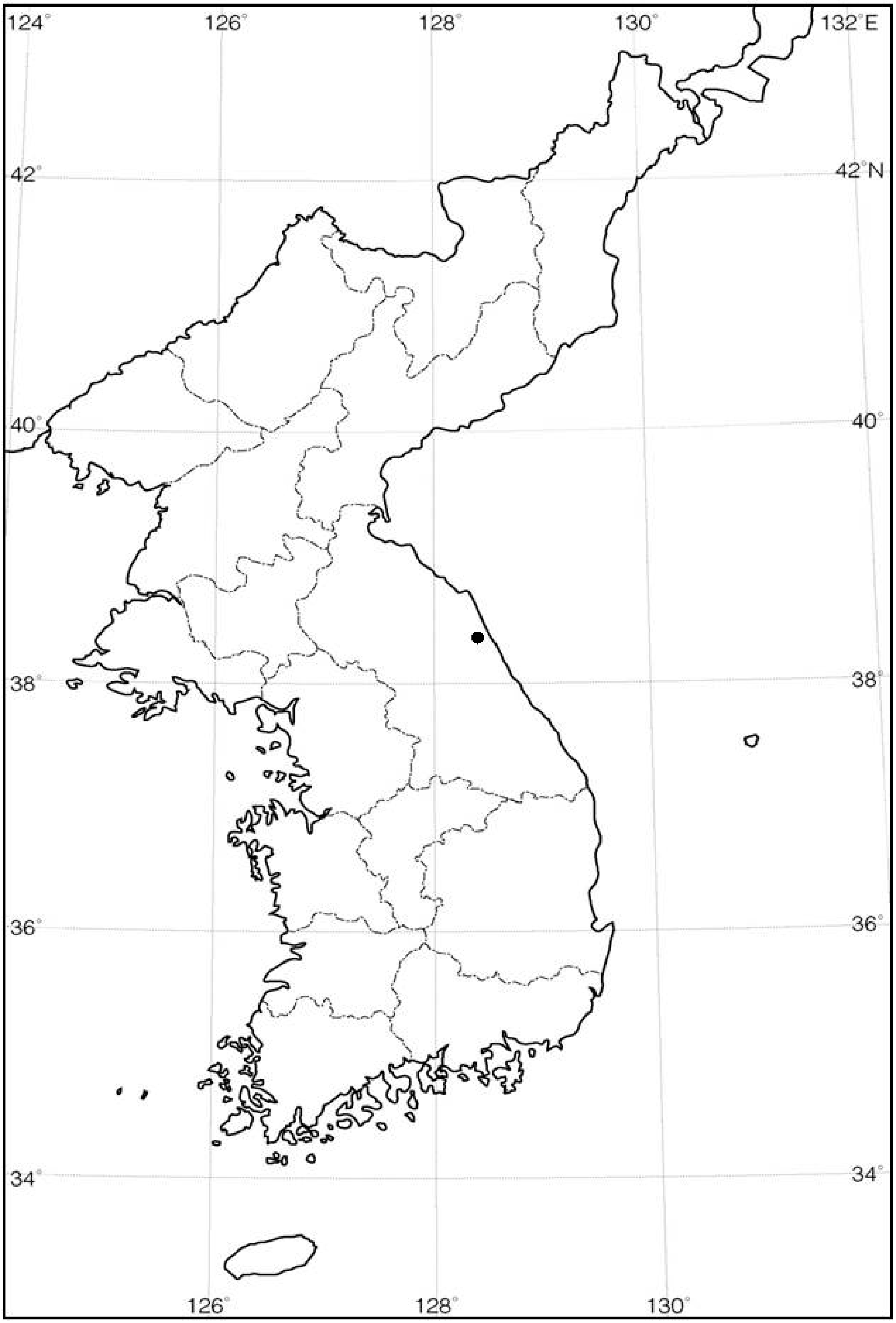

Fig. 25. Distribution of *B. koreana*

Fig. 26. Holotype of *Bistorta koreana* C. W. Park & G. S. Bhandari

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Appendix 1.

Aligned sequences of nrDNA ITS region from taxa of the *B. manshuriensis* complex and related taxa. See Table 4 for acronyms. Dashes (-) indicate gaps and dots (.) indicate matched sequences to the first taxon.

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                                                                                                                             110
A1_kr_gr1 c1       TCGAAACCTGCACAAGCAGAAAGACCCGCGAACTCGTTTACAAACACCCGAGGGGCAGGGCTCGGCCAAAACCGGCGCTGCCCCTCACACCAACGAACCCCGGCGCGGAT
A1_kr_gr1 c2       ..............................................................................................................
A2_kr_hl3 c1       ..............................................................................................................
A2_kr_hl3 c2       ..............................................................................................................
A2_kr_hl5 c1       ..............................................................................................................
A2_kr_hl5 c2       ..............................................................T...............................................
A3_kr_hl5 c1       ..............................................................................................................
A3_kr_hl5 c2       ..............................................................................................................
A4_kr_hl9 c1       ..............................................................................................................
A4_kr_hl9 c2       ..............................................................................................................
A5_kr_hl10 c2      ...............................................................A..............................................
A5_kr_hl10 c1      ..............................................................T...............................................
A5_kr_hl10 c3      ..............................................................................................................
A5_kr_hl10 c4      ..............................................................T...............................................
A5_kr_hl10 c5      ..............................................................................................................
A5_kr_hl10 c6      ...............................................................A..............................................
A5_kr_hl11 c1      ..............................................................................................................
A5_kr_hl11 c2      ..............................................................................................................
A7_mn_1            ..............................................................................................................
A8_mn_2 c1         ..............................................................................................................
A8_mn_2 c2         ..............................................................................................................
M2_rs_kh1 c1       ..............................................................................................................
M2_rs_kh1 c2       ..............................................................................................................
M2_rs_kh3 c1       ..............................................................................................................
M2_rs_kh3 c2       ..............................................................................................................
M2_rs_kh3 c3       ..............................................................................................................
M2_rs_kh3 c4       ..............................................................................................................
M3_rs_kh6 c1       ..............................................................................................................
M3_rs_kh6 c2       ..............................................................................................................
M3_rs_kh8 c1       ..............................................................................................................
M3_rs_kh8 c2       ..............................................................................................................
M3_rs_kh20 c1      ..............................................................................................................
M3_rs_kh20 c2      ..............................................................................................................
M3_rs_kh22 c1      ..............................................................................................................
M3_rs_kh23 c1      ..............................................................................................................
M3_rs_kh23 c2      ..............................................................................................................
M3_rs_kh24         ..............................................................................................................
M3_rs_kh25 c1      ..............................................................................................................
M3_rs_kh25 c2      ..............................................................................................................
M3_rs_kh28 c1      ..............................................................................................................
M3_rs_kh28 c2      ..............................................................................................................
M3_rs_kh29         ..............................................................................................................
M3_rs_kh31 c1      ..............................................................................................................
M3_rs_kh31 c2      ..............................................................................................................
M3_rs_kh31 c3      ..............................................................................................................
M3_rs_kh31_1 c1    ..............................................................................................................
M3_rs_kh31_1 c2    ..............................................................................................................
M4_rs_kh32 c1      ..............................................................................................................
M4_rs_kh32 c2      ................................................T.............................................................
M5_rs_ot1          ..............................................................................................................
M6_rs_is2 c1       ..............................................................................................................
M6_rs_is2 c2       ..............................................................................................................
M7_cn_hj0 c1       ..............................................................................................................
M7_cn_hj0 c2       ..............................................................................................................
M8_cn_hj3_1 c1     ..........................................................................A...................................
M8_cn_hj3_1 c2     ..............................................................................................................
M8_cn_hj2          ..............................................................................................................
M8_cn_hj4          ..............................................................................................................
M8_cn_hj5 c1       ..............................................................................................................
M8_cn_hj5 c2       ..............................................................................................................
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Appendix 1. (Continued).

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                                                                                                                              110
A1_kr_gr1 c1       TCGAAACCTGCACAAGCAGAAAGACCCGCGAACTCGTTTACAAACACCCGAGGGGCAGGGCTCGGCCAAAACCGGCGCTGCCCCTCACACCAACGAACCCCGGCGCGGAT
M9_cn_hj5          ..............................................................................................................
M13_kr_od c1       ..............................................................................................................
M13_kr_od c2       ..............................................................................................................
M13_kr_od c3       ..............................................................T...............................................
M14_kr_jm1 c1      ..............................................................................................................
M14_kr_jm1 c2      ..............................................................T...............................................
M16_kr_dr1 c1      ..............................................................................................................
M16_kr_dr1 c2      ..............................................................................................................
M18_kr_hg1 c1      ..............................................................................................................
M18_kr_hg1 c2      ..............................................................................................................
M20_kr_nh1 c1      ..............................................................T...............................................
M20_kr_nh1 c2      ..............................................................................................................
M20_kr_nh1 c3      ..............................................................................................................
M20_kr_nh1 c4      ..............................................................T...............................................
M21_kr_gu1 c1      ..............................................................................................................
M21_kr_gu1 c2      ..............................................................................................................
M21_kr_gu1 c3      ...............................................................A..............................................
M21_kr_gu1 c4      ..............................................................................................................
M22_kr_mp1 c1      ..............................................................................................................
M22_kr_mp1 c2      ..............................................................................................................
M25_kr_os2 c1      ..............................................................................................................
M25_kr_os2 c2      ..............................................................................................................
M25_kr_os3         ..............................................................................................................
M25_kr_os4 c1      ..............................................................................................................
M25_kr_os4 c2      ..............................................................................................................
M28_kr_bs1         ..............................................................................................................
M28_kr_bs2 c1      ..............................................................................................................
M28_kr_bs2 c2      ..............................................................................................................
M28_kr_bs2 c3      ..............................................................T...............................................
M30_kr_bl2 c1      ..............................................................................................................
M30_kr_bl2 c2      ..............................................................T...............................................
M32_kr_mt1 c1      ..............................................................T...............................................
M32_kr_mt1 c2      ..............................................................................................................
M33_kr_md2 c1      ..............................................................................................................
M33_kr_md2 c2      ..............................................................................................................
M34_kr_dn1 c1      ..............................................................................................................
M34_kr_dn1 c2      ..............................................................................................................
M34_kr_dn2 c1      ..............................................................................................................
M34_kr_dn2 c2      ..............................................................T...............................................
M35_kr_sm1 c1      ..............................................................................................................
M35_kr_sm1 c2      ..............................................................T...............................................
M35_kr_sm2 c1      ..............................................................................................................
M35_kr_sm2 c2      ..............................................................................................................
P1_rs_ms1 c1       ..............................................................T...............................................
P1_rs_ms1 c2       ..............................................................................................................
P1_rs_ms3 c1       ..............................................................................................................
P1_rs_ms3 c2       ..............................................................T...............................................
P1_rs_ms3 c3       ..............................................................T...............................................
P1_rs_ms3 c4       ..............................................................T...............................................
P1_rs_ms3 c5       ..............................................................................................................
P2_rs_nk2          ..............................................................................................................
P3_rs_pr1          ..............................................................................................................
P4_rs_pr2 c1       ..............................................................................................................
P4_rs_pr2 c2       ..............................................................................................................
P4_rs_pr2 c3       ......................................................C.......................................................
P4_rs_pr3 c1       ..............................................................................................................
P4_rs_pr3 c2       ......................................................C.......................................................
P5_rs_rc1 c1       ..............................................................................................................
P5_rs_rc1 c2       ..............................................................................................................
P5_rs_rc1 c3       ..............................................................................................................
P5_rs_rc1 c4       ..............................................................................................................
P5_rs_rc1 c5       ..............................................................................................................
P6_rs_rc7          ..............................................................................................................
P7_rs_us1          ..............................................................................................................
P7_rs_us2 c1       ..............................................................................................................
P7_rs_us2 c2       ..............................................................T...............................................
P7_rs_us2 c3       ..............................................................T...............................................
P7_rs_us2 c4       ..............................................................................................................
P7_rs_us2 c5       ..............................................................A...............................................
```

Appendix 1. (Continued).

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                                                                                                                            110
A1_kr_gr1 c1     TCGAAACCTGCACAAGCAGAAAGACCCGCGAACTCGTTTACAAACACCCGAGGGGCAGGGCTCGGCCAAAACCGGCGCTGCCCCTCACACCAACGAACCCCGGCGCGGAT
P9_rs_pr5        ..............................................................................................................
P10_cn_jl1 c1    ..............................................................................................................
P10_cn_jl1 c2    ..............................................................................................................
P11_cn_jl3 c1    ..............................................................................................................
P11_cn_jl3 c2    ..............................................................................................................
P11_cn_jl4 c1    ..............................................................T...............................................
P11_cn_jl4 c2    ..............................................................................................................
P12_cn_sn2 c1    ..............................................................T...............................................
P12_cn_sn2 c2    ..............................................................................................................
P12_cn_sn2 c3    ..............................................................................................................
P12_cn_sn2 c4    ..............................................................................................................
P13_cn_mc1 c1    ..............................................................T...............................................
P13_cn_mc1 c2    ..............................................................................................................
P13_cn_mc1 c3    ..............................................................................................................
P13_cn_mc2 c1    ..............................................................T...............................................
P13_cn_mc2 c2    ..............................................................................................................
P13_cn_mc2 c3    ..............................................................................................................
P13_cn_mc2 c4    ..............................................................................................................
P14_kr_hw1 c1    ..............................................................................................................
P14_kr_hw1 c2    ..............................................................T...............................................
P14_kr_hw1 c3    ..............................................................T...............................................
P15_kr_dm1 c1    ..............................................................T...............................................
P15_kr_dm1 c2    ..............................................................T...............................................
P15_kr_dm1 c3    ..............................................................................................................
P16_kr_sk2 c1    ..............................................................T...............................................
P16_kr_sk2 c2    ..............................................................T...............................................
P16_kr_sk2 c3    ..............................................................................................................
P16_kr_sk5 c1    ..............................................................T...............................................
P16_kr_sk5 c2    ..............................................................T...............................................
P17_kr_sh1 c1    ..............................................................................................................
P17_kr_sh1 c2    ..............................................................T...............................................
P17_kr_sh1 c3    ..............................................................T...............................................
P17_kr_sh1 c4    ..............................................................................................................
P17_kr_sh1 c5    ..............................................................................................................
P17_kr_sh1 c6    ..............................................................................................................
P19_kr_gw1 c1    ..............................................................................................................
P19_kr_gw1 c2    ..............................................................................................................
P19_kr_gw1 c3    ..............................................................T...............................................
P19_kr_gw1 c4    ..............................................................T...............................................
P19_kr_gw3 c1    ..............................................................................................................
P19_kr_gw3 c2    ..............................................................T...............................................
P19_kr_gw3 c3    ..............................................................T...............................................
P20_kr_ck1 c1    ..............................................................T...............................................
P20_kr_ck1 c2    ..............................................................T...............................................
P20_kr_ck1 c3    ..............................................................T...............................................
P20_kr_ck1 c4    ..............................................................................................................
P20_kr_ck1 c5    ..............................................................................................................
P21_kr_hc1 c1    ..............................................................................................................
P21_kr_hc1 c2    ..............................................................T...............................................
P21_kr_hc1 c3    ..............................................................................................................
P21_kr_hc1 c4    ..............................................................................................................
P21_kr_hc1 c5    ..............................................................T...............................................
P24_kr_mh2 c1    ..............................................................................................................
P24_kr_mh2 c2    ..............................................................................................................
P24_kr_mh2 c3    ..............................................................T...............................................
P24_kr_mh2 c4    ..............................................................T...............................................
P25_kr_tb1 c1    ..............................................................................................................
P25_kr_tb1 c2    ..............................................................................................................
P25_kr_tb1 c3    ...........................................................................................C..................
P25_kr_tb1 c4    ..............................................................T...............................................
P25_kr_tb1 c5    ..............................................................T...............................................
P27_kr_so1 c1    ..............................................................................................................
P27_kr_so1 c2    ..............................................................T...............................................
P27_kr_so1 c3    ..............................................................T...............................................
P28_kr_il1 c1     ..............................................................................................................
P28_kr_il1 c2     ..............................................................................................................
P28_kr_il1 c3     ..............................................................................................................
P28_kr_il1 c4     ..............................................................T...............................................
P28_kr_il1 c5     ..............................................................T...............................................
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Appendix 1. (Continued).

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                                                                                                                            110
A1_kr_gr1 c1     TCGAAACCTGCACAAGCAGAAAGACCCGCGAACTCGTTTACAAACACCCGAGGGGCAGGGCTCGGCCAAAACCGGCGCTGCCCCTCACACCAACGAACCCCGGCGCGGAT
P29_kr_mj1 c1    ..............................................................T...............................................
P29_kr_mj1 c2    ..............................................................T...............................................
P29_kr_mj1 c3    ..............................................................................................................
P29_kr_mj2       ..............................................................................................................
P30_kr_dk1 c1    ..............................................................................................................
P30_kr_dk1 c2    ..............................................................................................................
P30_kr_dk1 c3    ..............................................................T...............................................
P30_kr_dk1 c4    ..............................................................T...............................................
P31_kr_jr1 c1    ..............................................................................................................
P31_kr_jr1 c2    ..............................................................T...............................................
P31_kr_jr1 c3    ..............................................................................................................
O1_jp_rb1 c1     ..............................................................T...............................................
O1_jp_rb1 c2     ..............................................................T...............................................
O1_jp_rb1 c3     ..............................................................T...............................................
O1_jp_rb1 c4     ..............................................................................................................
O1_jp_rb1 c5     ..............................................................................................................
O1_jp_rb1 c6     ............................T.................................................................................
O2_jp_hk2 c1     ..............................................................T...............................................
O2_jp_hk2 c2     ............................T.................................................................................
O2_jp_hk2 c3     ..............................................................................................................
O2_jp_hk2 c4     ..............................................................................................................
J1_jp_hn2 c1     ..............................................................T...............................................
B1_cn_bj1        ..............................................................................................................
B2_uk_1          ..............................................................................................................
SUF_hl_1         ........................................................G....C................C...............................
SUF_hl_2         ........................................................G....C................C...............................
AMP_cn1          ........................................................G....C.........Y......................................
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Appendix 1. (Continued).

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                                                                                                                             220
A1_kr_gr1 c1      TGCGCCAAGGACCATGAACAATAGCGCGCCGCCCGCCACTCGGTCATCCGGTGTGCGAGCGGCGACGTGTCGTTTCGATAC-TAACTGAACGACTCTCGGCAACGGATAT
A1_kr_gr1 c2      .................................................................................-............................
A2_kr_hl3 c1      .................................................................................-............................
A2_kr_hl3 c2      .................................................................................-............................
A2_kr_hl5 c1      .................................................................................-............................
A2_kr_hl5 c2      .................................................................................-............................
A3_kr_hl5 c1      .................................................................................-............................
A3_kr_hl5 c2      .................................................................................-............................
A4_kr_hl9 c1      .................................................................................-............................
A4_kr_hl9 c2      .................................................................................-............................
A5_kr_hl10 c1     .................................................................................-............................
A5_kr_hl10 c2     .................................................................................-............................
A5_kr_hl10 c3     .................................................................................-............................
A5_kr_hl10 c4     .................................................................................-............................
A5_kr_hl10 c5     .................................................................................-............................
A5_kr_hl10 c6     .................................T...............................................-............................
A5_kr_hl11 c1     .................................................................................-............................
A5_kr_hl11 c2     .................................................................................-............................
A7_mn_1           .................................................................................-............................
A8_mn_2 c1        .................................................................................-............................
A8_mn_2 c2        .................................................................................-............................
M2_rs_kh1 c1      .................................................................................-............................
M2_rs_kh1 c2      .................................................................................-............................
M2_rs_kh3 c1      .................................................................................-.................A..........
M2_rs_kh3 c2      .................................................................................-............................
M2_rs_kh3 c3      .................................................................................-............................
M2_rs_kh3 c4      .................................................................................-............................
M3_rs_kh6 c1      .................................................................................-............................
M3_rs_kh6 c2      .................................................................................-............................
M3_rs_kh8 c1      .................................................................................-............................
M3_rs_kh8 c2      .................................................................................-............................
M3_rs_kh20 c1     .................................................................................-............................
M3_rs_kh20 c2     .................................................................................-............................
M3_rs_kh22        .................................................................................-............................
M3_rs_kh23 c1     .................................................................................-............................
M3_rs_kh23 c2     .................................................................................-............................
M3_rs_kh24        .................................................................................-............................
M3_rs_kh25 c1     .................................................................................-............................
M3_rs_kh25 c2     .................................................................................-............................
M3_rs_kh28 c1     .................................................................................-............................
M3_rs_kh28 c2     .................................................................................-............................
M3_rs_kh29        .................................................................................-............................
M3_rs_kh31 c1     .................................................................................-............................
M3_rs_kh31 c2     .................................................................................-.................A..........
M3_rs_kh31 c3     .................................................................................-............................
M3_rs_kh31_1 c1   .................................................................................-............................
M3_rs_kh31_2 c2   .................................................................................-............................
M4_rs_kh32 c1     .............................................................................-............................
M4_rs_kh32 c2     .................................................................................-............................
M5_rs_ot1         .................................................................................-............................
M6_rs_is2 c1      .................................................................................-............................
M6_rs_is2 c2      .................................................................................-............................
M7_cn_hj0 c1      .................................................................................-............................
M7_cn_hj0 c2      .................................................................................-............................
M8_cn_hj3_1 c1    .................................................................................-............................
M8_cn_hj3_1 c2    .................................................................................-............................
M8_cn_hj2         .................................................................................-............................
M8_cn_hj4         .................................................................................-............................
M8_cn_hj5 c1      .................................................................................-............................
M8_cn_hj5 c2      .................................................................................-............................
M9_cn_hj5         .................................................................................-............................
M13_kr_od c1      .................................................................................-............................
M13_kr_od c2      .................................................................................-............................
M13_kr_od c3      .................................................................................-............................
M14_kr_jm1 c1     .................................................................................-............................
M14_kr_jm1 c2     .................................................................................-............................
M16_kr_dr1 c1     .................................................................................-............................
M16_kr_dr1 c2     .................................................................................-............................
M18_kr_hg1 c1     .................................................................................-............................
M18_kr_hg1 c2     .................................................................................-............................
```

Appendix 1. (Continued).

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                                                                                                                      220
A1_kr_gr1 c1    TGCGCCAAGGACCATGAACAATAGCGCGCCGCCCGCCACTCGGTCATCCGGTGTGCGAGCGGCGACGTGTCGTTTCGATAC-TAACTGAACGACTCTCGGCAACGGATAT
M20_kr_nh1 c1   .................................................................................-............................
M20_kr_nh1 c2   .................................................................................-............................
M20_kr_nh1 c3   .................................................................................-............................
M20_kr_nh1 c4   .................................................................................-............................
M21_kr_gu1 c1   .................................................................................-............................
M21_kr_gu1 c2   .................................................................................-............................
M21_kr_gu1 c3   .................................T...............................................-............................
M21_kr_gu1 c4   .................................................................................-............................
M22_kr_mp1 c1   .................................................................................-............................
M22_kr_mp1 c2   .................................................................................-............................
M25_kr_os2 c1   .................................................................................-............................
M25_kr_os2 c2   .................................................................................-............................
M25_kr_os3      .................................................................................-............................
M25_kr_os4 c1   .................................................................................-............................
M25_kr_os4 c2   .................................................................................-............................
M28_kr_bs1      .................................................................................-............................
M28_kr_bs2 c1   .................................................................................-............................
M28_kr_bs2 c2   .................................................................................-............................
M28_kr_bs2 c3   .................................................................................-............................
M30_kr_bl2 c1   .................................................................................-............................
M30_kr_bl2 c2   .................................................................................-............................
M32_kr_mt1 c1   .................................................................................-............................
M32_kr_mt1 c2   .................................................................................-............................
M33_kr_md2 c1   .................................................................................-............................
M33_kr_md2 c2   ...........................................................................T.....-............................
M34_kr_dn1 c1   .................................................................................-............................
M34_kr_dn1 c2   .................................................................................-............................
M34_kr_dn2 c1   .................................................................................-............................
M34_kr_dn2 c2   .................................................................................-............................
M35_kr_sm1 c1   .................................................................................-............................
M35_kr_sm1 c2   .................................................................................-............................
M35_kr_sm2 c1   .................................................................................-............................
M35_kr_sm2 c2   .................................................................................-............................
P1_rs_ms1 c1    .................................................................................C............................
P1_rs_ms1 c2    .................................................................................-............................
P1_rs_ms3 c1    .................................................................................-............................
P1_rs_ms3 c2    .................................................................................-............................
P1_rs_ms3 c3    .................................................................................C............................
P1_rs_ms3 c4    .................................................................................C............................
P1_rs_ms3 c5    .................................................................................-............................
P2_rs_nk2       .................................................................................-............................
P3_rs_pr1       .................................................................................-............................
P4_rs_pr2 c1    .................................................................................-............................
P4_rs_pr2 c2    .................................................................................-............................
P4_rs_pr2 c3    .................................................................................-............................
P4_rs_pr3 c1    .................................................................................-............................
P4_rs_pr3 c2    .................................................................................-............................
P5_rs_rc1 c1    .................................................................................-............................
P5_rs_rc1 c2    .................................................................................-............................
P5_rs_rc1 c3    ..................................................................A..............-............................
P5_rs_rc1 c4    .................................G...............................................-............................
P5_rs_rc1 c5    .................................................................................-............................
P6_rs_rc7       .................................................................................-............................
P7_rs_us1 c1    .................................................................................-............................
P7_rs_us2 c1    .................................................................................-............................
P7_rs_us2 c2    .................................................................................-............................
P7_rs_us2 c3    .................................................................................-............................
P7_rs_us2 c4    .................................................................................-............................
P7_rs_us2 c5    .................................................................................-............................
P9_rs_pr5       .................................................................................-............................
P10_cn_jl1 c1   .................................................................................-............................
P10_cn_jl1 c2   .................................................................................-............................
P11_cn_jl3 c1   .................................................................................-............................
P11_cn_jl3 c2   .................................................................................-............................
P11_cn_jl4 c1   .................................................................................-............................
P11_cn_jl4 c2   .................................................................................-............................
P12_cn_sn2 c1   .................................................................................-............................
P12_cn_sn2 c2   .................................................................................-............................
P12_cn_sn2 c3   .................................................................................-............................
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Appendix 1. (Continued).

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                                                                                                                            220
A1_kr_gr1 c1     TGCGCCAAGGACCATGAACAATAGCGCGCCGCCCGCCACTCGGTCATCCGGTGTGCGAGCGGCGACGTGTCGTTTCGATAC-TAACTGAACGACTCTCGGCAACGGATAT
P12_cn_sn2 c4    .................................................................................-............................
P13_cn_mc1 c1    .................................................................................-............................
P13_cn_mc1 c2    .................................................................................-............................
P13_cn_mc1 c3    .................................................................................-............................
P13_cn_mc2 c1    .................................................................................-............................
P13_cn_mc2 c2    .................................................................................-............................
P13_cn_mc2 c3    .................................................................................-............................
P13_cn_mc2 c4    .................................................................................-............................
P14_kr_hw1 c1    .................................................................................-............................
P14_kr_hw1 c2    .................................................................................-............................
P14_kr_hw1 c3    .................................................................................-............................
P15_kr_dm1 c1    .................................................................................-............................
P15_kr_dm1 c2    .................................................................................-............................
P15_kr_dm1 c3    .................................................................................-............................
P16_kr_sk2 c1    .................................................................................-............................
P16_kr_sk2 c2    .................................................................................-............................
P16_kr_sk2 c3    .............................................G...................................-............................
P16_kr_sk5 c1    .................................................................................-............................
P16_kr_sk5 c2    .................................................................................-............................
P17_kr_sh1 c1    .................................................................................-............................
P17_kr_sh1 c2    .................................................................................-............................
P17_kr_sh1 c3    .................................................................................-............................
P17_kr_sh1 c4    .................................................................................-............................
P17_kr_sh1 c5    .............................................G...................................-............................
P17_kr_sh1 c6    .................................................................................-............................
P19_kr_gw1 c1    .................................................................................-............................
P19_kr_gw1 c2    .................................................................................-............................
P19_kr_gw1 c3    .................................................................................-............................
P19_kr_gw1 c4    .................................................................................-............................
P19_kr_gw3 c1    .................................................................................-............................
P19_kr_gw3 c2    .................................................................................-............................
P19_kr_gw3 c3    .................................................................................-............................
P20_kr_ck1 c1    .................................................................................-............................
P20_kr_ck1 c2    .................................................................................-............................
P20_kr_ck1 c3    .................................................................................-............................
P20_kr_ck1 c4    .................................................................................-............................
P20_kr_ck1 c5    .................................................................................-............................
P21_kr_hc1       .................................................................................-............................
P24_kr_mh2 c1    .................................................................................-............................
P24_kr_mh2 c2    .................................................................................-............................
P24_kr_mh2 c3    .................................................................................-............................
P24_kr_mh2 c4    .................................................................................-............................
P21_kr_hc1 c1    .................................................................................-............................
P21_kr_hc1 c2    .................................................................................-............................
P21_kr_hc1 c3    .................................................................................-............................
P21_kr_hc1 c4    .................................................................................-............................
P25_kr_tb1 c1    .................................................................................-............................
P25_kr_tb1 c2    .................................................................................-............................
P25_kr_tb1 c3    .................................................................................-............................
P25_kr_tb1 c4    .................................................................................-............................
P25_kr_tb1 c5    .................................................................................-............................
P27_kr_so1 c1    .............................................G...................................-............................
P27_kr_so1 c2    .................................................................................-............................
P27_kr_so1 c3    .................................................................................-............................
P28_kr_il1 c1    .............................................G...................................-............................
P28_kr_il1 c2    .................................................................................-............................
P28_kr_il1 c3    .................................................................................-............................
P28_kr_il1 c4    .................................................................................-............................
P28_kr_il1 c5    .................................................................................-............................
P29_kr_mj1 c1    .................................................................................-............................
P29_kr_mj1 c2    .................................................................................-............................
P29_kr_mj1 c3    .................................................................................-............................
P29_kr_mj2       .................................................................................-............................
P30_kr_dk1 c1    .................................................................................-............................
P30_kr_dk1 c2    .................................................................................-............................
P30_kr_dk1 c3    .................................................................................-............................
P30_kr_dk1 c4    .................................................................................-............................
P31_kr_jr1 c1    .................................................................................-............................
P31_kr_jr1 c2    .................................................................................-............................
```

Appendix 1. (Continued).

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                                                                                                                             220
A1_kr_gr1 c1      TGCGCCAAGGACCATGAACAATAGCGCGCCGCCCGCCACTCGGTCATCCGGTGTGCGAGCGGCGACGTGTCGTTTCGATAC-TAACTGAACGACTCTCGGCAACGGATAT
P31_kr_jr1 c3     .................................................................................-............................
O1_jp_rb1 c1      .................................................................................C............................
O1_jp_rb1 c2      .................................................................................-............................
O1_jp_rb1 c3      .................................................................................-............................
O1_jp_rb1 c4      .................................................................................-............................
O1_jp_rb1 c5      .................................................................................-............................
O1_jp_rb1 c6      .................................................................................-............................
O2_jp_hk2 c1      .................................................................................-............................
O2_jp_hk2 c2      .................................................................................-............................
O2_jp_hk2 c3      .................................................................................-............................
O2_jp_hk2 c4      .................................................................................-............................
J1_jp_hn2         .................................................................................-............................
B1_cn_bj1         .................................................................................-............................
B2_uk_1           .................................................................................-............................
SUF_hl_1          .....................................G.C...........CK...........G................-....Y.......................
SUF_hl_2          .....................................G.C...........C............G................-....Y.......................
AMP_cn1           .................................................................................-............................
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Appendix 1. (Continued).

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                                                                                                                            330
A1_kr_gr1 c1     CTCGGCTCTCGCATCGATGAAGAACGTAGCGAAATGCGATACTTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTCTTTGAACGCAAGTTGCGCCCGAAGCCTTCGG
A1_kr_gr1 c2     ..............................................................................................................
A2_kr_hl5 c1     ..............................................................................................................
A2_kr_hl5 c2     ..............................................................................................................
A2_kr_hl3 c1     ............................................................................................................
A2_kr_hl3 c2     ..............................................................................................................
A3_kr_hl5 c1     ..............................................................................................................
A3_kr_hl5 c2     ..............................................................................................................
A4_kr_hl9 c1     ..............................................................................................................
A4_kr_hl9 c2     ..............................................................................................................
A5_kr_hl10 c1    ..............................................................................................................
A5_kr_hl10 c2    ..............................................................................................................
A5_kr_hl10 c3    ..............................................................................................................
A5_kr_hl10 c4    ..............................................................................................................
A5_kr_hl10 c5    ..............................................................................................................
A5_kr_hl10 c6    ..............................................................................................................
A5_kr_hl11 c1    ..............................................................................................................
A5_kr_hl11 c2    ..............................................................................................................
A7_mn_1          ..............................................................................................................
A8_mn_2 c1       ..............................................................................................................
A8_mn_2 c2       ..............................................................................................................
M2_rs_kh1 c1     ..............................................................................................................
M2_rs_kh1 c2     ..............................................................................................................
M2_rs_kh3 c1     ..............................................................................................................
M2_rs_kh3 c2     ..............................................................................................................
M2_rs_kh3 c3     ..............................................................................................................
M2_rs_kh3 c4     ..............................................................................................................
M3_rs_kh6 c1     ..............................................................................................................
M3_rs_kh6 c2     ..............................................................................................................
M3_rs_kh8 c1     ..............................................................................................................
M3_rs_kh8 c2     ..............................................................................................................
M3_rs_kh20 c1    ..............................................................................................................
M3_rs_kh20 c2    ..............................................................................................................
M3_rs_kh22       ..............................................................................................................
M3_rs_kh23 c1    ..............................................................................................................
M3_rs_kh23 c2    ..............................................................................................................
M3_rs_kh24       ..............................................................................................................
M3_rs_kh25 c1    ..............................................................................................................
M3_rs_kh25 c2    ..............................................................................................................
M3_rs_kh28 c1    ..............................................................................................................
M3_rs_kh28 c2    ..............................................................................................................
M3_rs_kh29       ..............................................................................................................
M3_rs_kh31 c1    ..............................................................................................................
M3_rs_kh31 c2    ..............................................................................................................
M3_rs_kh31 c3    ..............................................................................................................
M3_rs_kh31_1 c1  ..............................................................................................................
M3_rs_kh31_1 c2  ..............................................................................................................
M4_rs_kh32 c1    ..............................................................................................................
M4_rs_kh32 c2    ..............................................................................................................
M5_rs_ot1        ..............................................................................................................
M6_rs_is2 c1     ..............................................................................................................
M6_rs_is2 c2     ..............................................................................................................
M7_cn_hj0 c1     ..............................................................................................................
M7_cn_hj0 c2     ..............................................................................................................
M8_cn_hj3_1 c1   ..............................................................................................................
M8_cn_hj3_1 c2   ..............................................................................................................
M8_cn_hj2        ..............................................................................................................
M8_cn_hj4        ..............................................................................................................
M8_cn_hj5 c1     ..............................................................................................................
M8_cn_hj5 c2     ..............................................................................................................
M9_cn_hj5        ..............................................................................................................
M13_kr_od c1     ..............................................................................................................
M13_kr_od c2     ..............................................................................................................
M13_kr_od c3     ..............................................................................................................
M14_kr_jm1 c1    ..............................................................................................................
M14_kr_jm1 c2    ..............................................................................................................
M16_kr_dr1 c1    ..............................................................................................................
M16_kr_dr1 c2    ..............................................................................................................
M18_kr_hg1 c1    ..............................................................................................................
M18_kr_hg1 c2    ..............................................................................................................
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Appendix 1. (Continued).

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                                                                                                                           330
A1_kr_gr1 c1    CTCGGCTCTCGCATCGATGAAGAACGTAGCGAAATGCGATACTTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTCTTTGAACGCAAGTTGCGCCCGAAGCCTTCGG
M20_kr_nh1 c1   ..............................................................................................................
M20_kr_nh1 c2   ..............................................................................................................
M20_kr_nh1 c3   ..............................................................................................................
M20_kr_nh1 c4   ..............................................................................................................
M21_kr_gu1 c1   ..............................................................................................................
M21_kr_gu1 c2   ..............................................................................................................
M21_kr_gu1 c3   ..............................................................................................................
M21_kr_gu1 c4   ..............................................................................................................
M22_kr_mp1 c1   ..............................................................................................................
M22_kr_mp1 c2   ..............................................................................................................
M25_kr_os2 c1   ..............................................................................................................
M25_kr_os2 c2   ..............................................................................................................
M25_kr_os3      ..............................................................................................................
M25_kr_os4 c1   ..............................................................................................................
M25_kr_os4 c2   ..............................................................................................................
M28_kr_bs2 c1   ..............................................................................................................
M28_kr_bs2 c2   ..............................................................................................................
M28_kr_bs2 c3   ..............................................................................................................
M28_kr_bs1 c4   ..............................................................................................................
M30_kr_bl2 c1   ..............................................................................................................
M30_kr_bl2 c2   ..............................................................................................................
M32_kr_mt1 c1   ..............................................................................................................
M32_kr_mt1 c2   ..............................................................................................................
M33_kr_md2 c1   ..............................................................................................................
M33_kr_md2 c2   ..............................................................................................................
M34_kr_dn1 c1   ..............................................................................................................
M34_kr_dn1 c2   ..............................................................................................................
M34_kr_dn2 c1   ..............................................................................................................
M34_kr_dn2 c2   ..............................................................................................................
M35_kr_sm1 c1   ..............................................................................................................
M35_kr_sm1 c2   ..............................................................................................................
M35_kr_sm2 c1   ..............................................................................................................
M35_kr_sm2 c2   ..............................................................................................................
P1_rs_ms1 c1    ..............................................................................................................
P1_rs_ms1 c2    ..............................................................................................................
P1_rs_ms3 c1    ..............................................................................................................
P1_rs_ms3 c2    ..............................................................................................................
P1_rs_ms3 c3    ..............................................................................................................
P1_rs_ms3 c4    ..............................................................................................................
P1_rs_ms3 c5    ..............................................................................................................
P2_rs_nk2       ..............................................................................................................
P3_rs_pr1       ..............................................................................................................
P4_rs_pr2 c1    ..............................................................................................................
P4_rs_pr2 c2    ..............................................................................................................
P4_rs_pr2 c3    ..............................................................................................................
P4_rs_pr3 c1    ..............................................................................................................
P4_rs_pr3 c2    ..............................................................................................................
P5_rs_rc1 c1    ..............................................................................................................
P5_rs_rc1 c2    ..............................................................................................................
P5_rs_rc1 c3    ..............................................................................................................
P5_rs_rc1 c4    ..............................................................................................................
P5_rs_rc1 c5    ..............................................................................................................
P6_rs_rc7       ..............................................................................................................
P7_rs_us1       ..............................................................................................................
P7_rs_us2 c1    ..............................................................................................................
P7_rs_us2 c2    ..............................................................................................................
P7_rs_us2 c3    ..............................................................................................................
P7_rs_us2 c4    ..............................................................................................................
P7_rs_us2 c5    ..............................................................................................................
P9_rs_pr5       ..............................................................................................................
P10_cn_jl1 c1   ..............................................................................................................
P10_cn_jl1 c2   ..............................................................................................................
P11_cn_jl3 c1   ..............................................................................................................
P11_cn_jl3 c2   ..............................................................................................................
P11_cn_jl4 c1   ..............................................................................................................
P11_cn_jl4 c2   ..............................................................................................................
P12_cn_sn2 c1   ..............................................................................................................
P12_cn_sn2 c2   ..............................................................................................................
P12_cn_sn2 c3   ..............................................................................................................
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Appendix 1. (Continued).

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                                                                                                                     330
A1_kr_gr1 c1     CTCGGCTCTCGCATCGATGAAGAACGTAGCGAAATGCGATACTTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTCTTTGAACGCAAGTTGCGCCCGAAGCCTTCGG
P12_cn_sn2 c4    ..............................................................................................................
P13_cn_mc1 c1    ..............................................................................................................
P13_cn_mc1 c2    ..............................................................................................................
P13_cn_mc1 c3    ..............................................................................................................
P13_cn_mc2 c1    ..............................................................................................................
P13_cn_mc2 c2    ..............................................................................................................
P13_cn_mc2 c3    ..............................................................................................................
P13_cn_mc2 c4    ..............................................................................................................
P14_kr_hw1 c1    ..............................................................................................................
P14_kr_hw1 c2    ..............................................................................................................
P14_kr_hw1 c3    ..............................................................................................................
P15_kr_dm1 c1    ..............................................................................................................
P15_kr_dm1 c2    ..............................................................................................................
P15_kr_dm1 c3    ..............................................................................................................
P16_kr_sk2 c1    ..............................................................................................................
P16_kr_sk2 c2    ..............................................................................................................
P16_kr_sk2 c3    ..............................................................................................................
P16_kr_sk5 c1    ..............................................................................................................
P16_kr_sk5 c2    ..............................................................................................................
P17_kr_sh1 c1    ..............................................................................................................
P17_kr_sh1 c2    ..............................................................................................................
P17_kr_sh1 c3    ..............................................................................................................
P17_kr_sh1 c4    ..............................................................................................................
P17_kr_sh1 c5    ..............................................................................................................
P17_kr_sh1 c6    ...........................................................................................................A..
P19_kr_gw3 c1    ..............................................................................................................
P19_kr_gw3 c2    ..............................................................................................................
P19_kr_gw3 c3    ..............................................................................................................
P19_kr_gw1 c1    ..............................................................................................................
P19_kr_gw1 c2    ..............................................................................................................
P19_kr_gw1 c3    ..............................................................................................................
P19_kr_gw1 c4    ..............................................................................................................
P20_kr_ck1 c1    ..............................................................................................................
P20_kr_ck1 c2    ..............................................................................................................
P20_kr_ck1 c3    ..............................................................................................................
P20_kr_ck1 c4    ..............................................................................................................
P20_kr_ck1 c5    ..............................................................................................................
P21_kr_hc1       ..............................................................................................................
P24_kr_mh2 c1    ..............................................................................................................
P24_kr_mh2 c2    ..............................................................................................................
P24_kr_mh2 c3    ..............................................................................................................
P24_kr_mh2 c4    ..............................................................................................................
P21_kr_hc1 c1    ..............................................................................................................
P21_kr_hc1 c2    ..............................................................................................................
P21_kr_hc1 c3    ..............................................................................................................
P21_kr_hc1 c4    ..............................................................................................................
P25_kr_tb1 c1    ..............................................................................................................
P25_kr_tb1 c2    ..............................................................................................................
P25_kr_tb1 c3    ..............................................................................................................
P25_kr_tb1 c4    ..............................................................................................................
P25_kr_tb1 c5    ..............................................................................................................
P27_kr_so1 c1    ..............................................................................................................
P27_kr_so1 c2    ..............................................................................................................
P27_kr_so1 c3    ..............................................................................................................
P28_kr_il1 c1    ..............................................................................................................
P28_kr_il1 c2    ..............................................................................................................
P28_kr_il1 c3    ..............................................................................................................
P28_kr_il1 c4    ..............................................................................................................
P28_kr_il1 c5    ..............................................................................................................
P29_kr_mj2 c1    ..............................................................................................................
P29_kr_mj1 c2    ..............................................................................................................
P29_kr_mj1 c3    ..............................................................................................................
P29_kr_mj1 c4    ..............................................................................................................
P30_kr_dk1 c1    ..............................................................................................................
P30_kr_dk1 c2    ..............................................................................................................
P30_kr_dk1 c3    ..............................................................................................................
P30_kr_dk1 c4    ..............................................................................................................
P31_kr_jr1 c1    ..............................................................................................................
P31_kr_jr1 c2    ..............................................................................................................
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Appendix 1. (Continued).

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                                                                                                                            330
A1_kr_gr1 c1    CTCGGCTCTCGCATCGATGAAGAACGTAGCGAAATGCGATACTTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTCTTTGAACGCAAGTTGCGCCCGAAGCCTTCGG
P31_kr_jr1 c3   ..............................................................................................................
O1_jp_rb1 c1    ..............................................................................................................
O1_jp_rb1 c2    ..............................................................................................................
O1_jp_rb1 c3    ..............................................................................................................
O1_jp_rb1 c4    ..............................................................................................................
O1_jp_rb1 c5    ..............................................................................................................
O1_jp_rb1 c6    ..............................................................................................................
O2_jp_hk2 c1    ..............................................................................................................
O2_jp_hk2 c2    ..............................................................................................................
O2_jp_hk2 c3    ..............................................................................................................
O2_jp_hk2 c4    ..............................................................................................................
J1_jp_hn2       ..............................................................................................................
B1_cn_bj1       ..............................................................................................................
B2_uk_1         ..............................................................................................................
SUF_hl_1        ..............................................................................................................
SUF_hl_2        ..............................................................................................................
AMP_cn1         ..............................................................................................................
```

Appendix 1. (Continued).

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                                                                                                                            440
A1_kr_gr1 c1     GCCGAGGGCACGTCTGCATGGGCGTCACGCACAGCGTCGCCCCCACCCCATCCCGTGGGGCGTGGGGCGGATTCTGGCCCCCCGTGTGCTCCCGCGCGCGGTCGGCCTAA
A1_kr_gr1 c2     ..............................................................................................................
A2_kr_hl3 c1     ..............................................................A...............................................
A2_kr_hl3 c2     ..............................................................................................................
A2_kr_hl5 c1     ..............................................................................................................
A2_kr_hl5 c2     ..............................................................................................................
A3_kr_hl5 c1     ..............................................................................................................
A3_kr_hl5 c2     ....................................................T.........................................................
A4_kr_hl9 c1     ..............................................................................................................
A4_kr_hl9 c2     ....................................................T.........................................................
A5_kr_hl10 c1    ..............................................................................................................
A5_kr_hl10 c2    ....................................................T.........................................................
A5_kr_hl10 c3    ....................................................T.........................................................
A5_kr_hl10 c4    ..............................................................................................................
A5_kr_hl10 c5    ..............................................................................................................
A5_kr_hl10 c6    ..............................................................A...............................................
A5_kr_hl11 c1    ..............................................................A...............................................
A5_kr_hl11 c2    ..............................................................................................................
A7_mn_1          ..............................................................................................................
A8_mn_2 c1       ..............................................................................................................
A8_mn_2 c2       ..............................................................................................................
M2_rs_kh1 c1     ..............................................................................................................
M2_rs_kh1 c2     ..............................................................................................................
M2_rs_kh3 c1     ..............................................................A...............................................
M2_rs_kh3 c2     ..............................................................................................................
M2_rs_kh3 c3     ..............................................................................................................
M2_rs_kh3 c4     ..............................................................................................................
M3_rs_kh6 c1     ..............................................................A...............................................
M3_rs_kh6 c2     ..............................................................................................................
M3_rs_kh8 c1     ..............................................................A...............................................
M3_rs_kh8 c2     ..............................................................................................................
M3_rs_kh20 c1    ..............................................................A...............................................
M3_rs_kh20 c2    ..............................................................................................................
M3_rs_kh22 c1    ..............................................................................................................
M3_rs_kh23 c1    ..............................................................A...............................................
M3_rs_kh23 c2    ..............................................................................................................
M3_rs_kh24       ..............................................................................................................
M3_rs_kh25 c1    ..............................................................A...............................................
M3_rs_kh25 c2    ..............................................................................................................
M3_rs_kh28 c1    ..............................................................A...............................................
M3_rs_kh28 c2    ..............................................................................................................
M3_rs_kh29       ..............................................................................................................
M3_rs_kh31 c1    ..............................................................................................................
M3_rs_kh31 c2    ..............................................................................................................
M3_rs_kh31 c3    ..............................................................................................................
M3_rs_kh31_1 c1  ..............................................................A...............................................
M3_rs_kh31_2 c2  ..............................................................................................................
M4_rs_kh32 c1    ..............................................................................................................
M4_rs_kh32 c2    ..............................................................................................................
M5_rs_ot1        ..............................................................................................................
M6_rs_is2 c1     ..............................................................................................................
M6_rs_is2 c2     ..............................................................................................................
M7_cn_hj0 c1     ..............................................................................................................
M7_cn_hj0 c2     ....................................................T.........................................................
M8_cn_hj2        ..............................................................................................................
M8_cn_hj4        ..............................................................................................................
M8_cn_hj5 c1     ..............................................................................................................
M8_cn_hj5 c2     ..............................................................................................................
M8_cn_hj3_1 c1   ..............................................................................................................
M8_cn_hj3_1 c2   ..............................................................................................................
M9_cn_hj5        ..............................................................................................................
M13_kr_od c1     ..............................................................A...............................................
M13_kr_od c2     ..............................................................................................................
M13_kr_od c3     ....................................................T.........................................................
M14_kr_jm1 c1    ....................................................T.........................................................
M14_kr_jm1 c2    ....................................................T.........................................................
M16_kr_dr1 c1    ..............................................................................................................
M16_kr_dr1 c2    ....................................................T.........................................................
M18_kr_hg1 c1    ..............................................................................................................
M18_kr_hg1 c2    ....................................................T.........................................................
```

Appendix 1. (Continued).

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                                                                                                                           440
A1_kr_gr1 c1    GCCGAGGGCACGTCTGCATGGGCGTCACGCACAGCGTCGCCCCCACCCCATCCCGTGGGGCGTGGGGCGGATTCTGGCCCCCCGTGTGCTCCCGCGCGCGGTCGGCCTAA
M20_kr_nh1 c1   ..............................................................................................................
M20_kr_nh1 c2   ....................................................T.........................................................
M20_kr_nh1 c3   ....................................................T.........................................................
M20_kr_nh1 c4   ..............................................................................................................
M21_kr_gu1 c1   ..............................................................................................................
M21_kr_gu1 c2   ....................................................T.........................................................
M21_kr_gu1 c3   ..............................................................A...............................................
M21_kr_gu1 c4   ..............................................................A...............................................
M22_kr_mp1 c1   ..............................................................A...............................................
M22_kr_mp1 c2   ..............................................................................................................
M25_kr_os2 c1   ..............................................................A...............................................
M25_kr_os2 c2   ..............................................................................................................
M25_kr_os3      ....................................................T.........................................................
M25_kr_os4 c1   ..............................................................A...............................................
M25_kr_os4 c2   ..............................................................................................................
M28_kr_bs2 c1   ....................................................T.........................................................
M28_kr_bs2 c2   ..............................................................................................................
M28_kr_bs2 c3   ..............................................................................................................
M28_kr_bs1 c4   ..............................................................................................................
M30_kr_bl2 c1   ..............................................................................................................
M30_kr_bl2 c2   ..............................................................................................................
M32_kr_mt1 c1   ..............................................................................................................
M32_kr_mt1 c2   ..............................................................................................................
M33_kr_md2 c1   ..............................................................................................................
M33_kr_md2 c2   ..............................................................................................................
M34_kr_dn1 c1   ..............................................................................................................
M34_kr_dn1 c2   ....................................................T.........................................................
M34_kr_dn2 c1   ..............................................................................................................
M34_kr_dn2 c2   ..............................................................................................................
M35_kr_sm1 c1   ..............................................................................................................
M35_kr_sm1 c2   ..............................................................................................................
M35_kr_sm2 c1   ..............................................................A...............................................
M35_kr_sm2 c2   ..............................................................................................................
P1_rs_ms1 c1    ..............................................................................................................
P1_rs_ms1 c2    ..............................................................................................................
P1_rs_ms3 c1    ..............................................................................................................
P1_rs_ms3 c2    ..............................................................................................................
P1_rs_ms3 c3    ....................................................T.........................................................
P1_rs_ms3 c4    ..............................................................................................................
P1_rs_ms3 c5    ..............................................................................................................
P2_rs_nk2       ..............................................................................................................
P3_rs_pr1 c1    ..............................................................................................................
P4_rs_pr2 c2    ..............................................................................................................
P4_rs_pr2 c3    ..............................................................................................................
P4_rs_pr2 c4    ..............................................................................................................
P4_rs_pr3 c5    ..............................................................................................................
P4_rs_pr3 c5    ..............................................................................................................
P5_rs_rc1 c1    ....................................................T.........................................................
P5_rs_rc1 c2    ..............................................................................................................
P5_rs_rc1 c3    ..............................................................................................................
P5_rs_rc1 c4    ..............................................................................................................
P5_rs_rc1 c5    ..............................................................................................................
P6_rs_rc7       ..............................................................................................................
P7_rs_us1       ..............................................................................................................
P7_rs_us2 c1    ..............................................................................................................
P7_rs_us2 c2    ..............................................................................................................
P7_rs_us2 c3    ..............................................................................................................
P7_rs_us2 c4    ..............................................................................................................
P7_rs_us2 c5    ..............................................................................................................
P9_rs_pr5       ..............................................................................................................
P10_cn_jl1 c1   ..............................................................................................................
P10_cn_jl1 c2   ..............................................................................................................
P11_cn_jl3 c1   ..............................................................................................................
P11_cn_jl3 c2   ....................................................T.........................................................
P11_cn_jl4 c1   ..................................................T.........................................................
P11_cn_jl4 c2   ..............................................................................................................
P12_cn_sn2 c1   ....................................................T.........................................................
P12_cn_sn2 c2   ..............................................................................................................
P12_cn_sn2 c3   ..............................................................................................................
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Appendix 1. (Continued).

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                                                                                                                            440
A1_kr_gr1 c1     GCCGAGGGCACGTCTGCATGGGCGTCACGCACAGCGTCGCCCCCACCCCATCCCGTGGGGCGTGGGGCGGATTCTGGCCCCCCGTGTGCTCCCGCGCGCGGTCGGCCTAA
P12_cn_sn2 c4    ..............................................................................................................
P13_cn_mc1 c1    ..............................................................................................................
P13_cn_mc1 c2    ..............................................................................................................
P13_cn_mc1 c3    ..............................................................................................................
P13_cn_mc2 c1    ....................................................T.........................................................
P13_cn_mc2 c2    ....................................................T.........................................................
P13_cn_mc2 c3    ..............................................................................................................
P13_cn_mc2 c4    ..............................................................................................................
P14_kr_hw1 c1    ..............................................................................................................
P14_kr_hw1 c2    ....................................................T.........................................................
P14_kr_hw1 c3    ....................................................T.........................................................
P15_kr_dm1 c1    ....................................................T.........................................................
P15_kr_dm1 c2    ....................................................T.........................................................
P15_kr_dm1 c3    ..............................................................................................................
P16_kr_sk2 c1    ....................................................T.........................................................
P16_kr_sk2 c2    ....................................................T.........................................................
P16_kr_sk2 c3    ..............................................................................................................
P16_kr_sk5 c1    ....................................................T.........................................................
P16_kr_sk5 c2    ....................................................T.........................................................
P17_kr_sh1 c1    ..............................................................................................................
P17_kr_sh1 c2    ..............................................................................................................
P17_kr_sh1 c3    ....................................................T.........................................................
P17_kr_sh1 c4    ....................................................T.........................................................
P17_kr_sh1 c5    ..............................................................................................................
P17_kr_sh1 c6    ....................................................T.........................................................
P19_kr_gw3 c1    ..............................................................................................................
P19_kr_gw3 c2    ....................................................T.........................................................
P19_kr_gw3 c3    ....................................................T.........................................................
P19_kr_gw1 c1    ....................................................T.........................................................
P19_kr_gw1 c2    ..............................................................................................................
P19_kr_gw1 c3    ....................................................T.........................................................
P19_kr_gw1 c4    ....................................................T.........................................................
P20_kr_ck1 c1    ..............................................................................................................
P20_kr_ck1 c2    ....................................................T.........................................................
P20_kr_ck1 c3    ....................................................T.........................................................
P20_kr_ck1 c4    ..............................................................................................................
P20_kr_ck1 c5    ....................................................T.........................................................
P21_kr_hc1 c1    ..............................................................A...............................................
P24_kr_mh2 c1    ..............................................................A...............................................
P24_kr_mh2 c2    ..............................................................................................................
P24_kr_mh2 c3    ....................................................T.........................................................
P24_kr_mh2 c4    ..............................................................................................................
P21_kr_hc1 c1    ..............................................................................................................
P21_kr_hc1 c2    ....................................................T.........................................................
P21_kr_hc1 c3    ..............................................................................................................
P21_kr_hc1 c4    ....................................................T.........................................................
P25_kr_tb1 c1    ..............................................................................................................
P25_kr_tb1 c2    ....................................................T.........................................................
P25_kr_tb1 c3    ..............................................................................................................
P25_kr_tb1 c4    ....................................................T.........................................................
P25_kr_tb1 c5    ....................................................T.........................................................
P27_kr_so1 c1    ..............................................................................................................
P27_kr_so1 c2    ....................................................T.........................................................
P27_kr_so1 c3    ..............................................................................................................
P28_kr_il1 c1    ..............................................................................................................
P28_kr_il1 c2    ..............................................................................................................
P28_kr_il1 c3    ....................................................T.........................................................
P28_kr_il1 c4    ..............................................................................................................
P28_kr_il1 c5    ....................................................T.........................................................
P29_kr_mj1 c1    ....................................................T.........................................................
P29_kr_mj1 c2    ..............................................................................................................
P29_kr_mj1 c3    ..............................................................................................................
P29_kr_mj2       ....................................................T.........................................................
P30_kr_dk1 c1    ....................................................T.........................................................
P30_kr_dk1 c2    ..............................................................................................................
P30_kr_dk1 c3    ..............................................................................................................
P30_kr_dk1 c4    ....................................................T.........................................................
P31_kr_jr1 c1    ....................................................T.........................................................
P31_kr_jr1 c2    ....................................................T.........................................................
```

Appendix 1. (Continued).

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                                                                                                                           440
A1_kr_gr1 c1    GCCGAGGGCACGTCTGCATGGGCGTCACGCACAGCGTCGCCCCCACCCCATCCCGTGGGGCGTGGGGCGGATTCTGGCCCCCCGTGTGCTCCCGCGCGCGGTCGGCCTAA
P31_kr_jr1 c3   ..............................................................................................................
O1_jp_rb1 c1    ..............................................................................................................
O1_jp_rb1 c2    ..............................................................................................................
O1_jp_rb1 c3    ...........................................................................................................A..
O1_jp_rb1 c4    ...........................................................................................................A..
O1_jp_rb1 c5    ..............................................................................................................
O1_jp_rb1 c6    ..............................................................................................................
O2_jp_hk2 c1    ..............................................................................................................
O2_jp_hk2 c2    ..............................................................................................................
O2_jp_hk2 c1    ..............................................................................................................
O2_jp_hk2 c2    ..............................................................................................................
J1_jp_hn2       ..............................................................................................................
B1_cn_bj1       ..............................................................................................................
B2_uk_1         ..............................................................................................................
SUF_hl_1        .................................................G-.T.........................................................
SUF_hl_2        .................................................G-.T.........................................................
AMP_cn1         ..................................................-.T.........................................................
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Appendix 1. (Continued).

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                                                                                                                            550
A1_kr_gr1 c1       AATCAGACCCCGTGGCCGCGAAATGCCGCGACGATTGGTGGTGTACGTGGCAGCCTCGTGCCGCCTAACATCGCGTCGCGCCTTCCGTGGCCCTCTGGAGTAAAAAGGAC
A1_kr_gr1 c2       ..............................................................................................................
A2_kr_hl3 c1       ..............................................................................................................
A2_kr_hl3 c2       ..............................................................................................................
A2_kr_hl5 c1       ..............................................................................................................
A2_kr_hl5 c2       ..............................................................................................................
A3_kr_hl5 c1       ..............................................................................................................
A3_kr_hl5 c2       ..............................................................................................................
A4_kr_hl9 c1       ..............................................................................................................
A4_kr_hl9 c2       ..............................................................................................................
A5_kr_hl10 c1      ..............................................................................................................
A5_kr_hl10 c2      ..............................................................................................................
A5_kr_hl10 c3      ..............................................................................................................
A5_kr_hl10 c4      ..............................................................................................................
A5_kr_hl10 c5      ..............................................................................................................
A5_kr_hl10 c6      ..............................................................................................................
A5_kr_hl11 c1      ..............................................................................................................
A5_kr_hl11 c2      ..............................................................................................................
A7_mn_1            ....................................................................G.........................................
A8_mn_2 c1         ....................................................................G.........................................
A8_mn_2 c2         ..............................................................................................................
M2_rs_kh1 c1       ..............................................................................................................
M2_rs_kh1 c2       ..............................................................................................................
M2_rs_kh3 c1       ..............................................................................................................
M2_rs_kh3 c2       ..............................................................................................................
M2_rs_kh3 c3       ..............................................................................................................
M2_rs_kh3 c4       ....................................................................................T.........................
M3_rs_kh6 c1       ..............................................................................................................
M3_rs_kh6 c2       ..............................................................................................................
M3_rs_kh8 c1       ..............................................................................................................
M3_rs_kh8 c2       ..............................................................................................................
M3_rs_kh20 c1      ..............................................................................................................
M3_rs_kh20 c2      ..............................................................................................................
M3_rs_kh22 c1      ..............................................................................................................
M3_rs_kh23 c2      ..............................................................................................................
M3_rs_kh23 c3      ..............................................................................................................
M3_rs_kh24         ..............................................................................................................
M3_rs_kh25 c1      ..............................................................................................................
M3_rs_kh25 c2      ..............................................................................................................
M3_rs_kh28 c1      ..............................................................................................................
M3_rs_kh28 c2      ..............................................................................................................
M3_rs_kh29         ..............................................................................................................
M3_rs_kh31 c1      ....................................................................................T................C.......
M3_rs_kh31 c2      ..............................................................................................................
M3_rs_kh31 c3      ..............................................................................................................
M3_rs_kh31_1 c1    ..............................................................................................................
M3_rs_kh31_2 c2    ..............................................................................................................
M4_rs_kh32 c1      ..............................................................................................................
M4_rs_kh32 c2      ..............................................................................................................
M5_rs_ot1          ..............................................................................................................
M6_rs_is2 c1       ..............................................................................................................
M6_rs_is2 c2       .......................................................................................................G......
M7_cn_hj0 c1       ..............................................................................................................
M7_cn_hj0 c2       ..............................................................................................................
M8_cn_hj3_1 c1     ..............................................................................................................
M8_cn_hj3_1 c2     ..............................................................................................................
M8_cn_hj2          ..............................................................................................................
M8_cn_hj4          ..............................................................................................................
M8_cn_hj5 c1       ..............................................................................................................
M8_cn_hj5 c2       ..............................................................................................................
M9_cn_hj5          ..............................................................................................................
M13_kr_od c1       ..............................................................................................................
M13_kr_od c2       ..............................................................................................................
M13_kr_od c3       ..............................................................................................................
M14_kr_jm1 c1      ..............................................................................................................
M14_kr_jm1 c2      ..............................................................................................................
M16_kr_dr1 c1      ..............................................................................................................
M16_kr_dr1 c2      ..............................................................................................................
M18_kr_hg1 c1      ..............................................................................................................
M18_kr_hg1 c2      ..............................................................................................................
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Appendix 1. (Continued).

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                                                                                                                            550
A1_kr_gr1 c1    AATCAGACCCCGTGGCCGCGAAATGCCGCGACGATTGGTGGTGTACGTGGCAGCCTCGTGCCGCCTAACATCGCGTCGCGCCTTCCGTGGCCCTCTGGAGTAAAAAGGAC
M20_kr_nh1 c1   ..............................................................................................................
M20_kr_nh1 c2   ..............................................................................................................
M20_kr_nh1 c3   ..............................................................................................................
M20_kr_nh1 c4   ..............................................................................................................
M21_kr_gu1 c1   ..............................................................................................................
M21_kr_gu1 c2   ..............................................................................................................
M21_kr_gu1 c3   ..............................................................................................................
M21_kr_gu1 c4   ..............................................................................................................
M22_kr_mp1 c1   ..............................................................................................................
M22_kr_mp1 c2   ..............................................................................................................
M25_kr_os2 c1   ..............................................................................................................
M25_kr_os2 c2   ..............................................................................................................
M25_kr_os3      ..............................................................................................................
M25_kr_os4 c1   ..............................................................................................................
M25_kr_os4 c2   ..............................................................................................................
M28_kr_bs1      ..............................................................................................................
M28_kr_bs2 c1   ..............................................................................................................
M28_kr_bs2 c2   ..............................................................................................................
M28_kr_bs2 c3   ..............................................................................................................
M30_kr_bl2 c1   ..............................................................................................................
M30_kr_bl2 c2   ..............................................................................................................
M32_kr_mt1 c1   ..............................................................................................................
M32_kr_mt1 c2   ..............................................................................................................
M33_kr_md2 c1   ..............................................................................................................
M33_kr_md2 c2   ..............................................................................................................
M34_kr_dn1 c1   ..............................................................................................................
M34_kr_dn1 c2   ..............................................................................................................
M34_kr_dn2 c1   ..............................................................................................................
M34_kr_dn2 c2   ..............................................................................................................
M35_kr_sm1 c1   ..............................................................................................................
M35_kr_sm1 c2   ..............................................................................................................
M35_kr_sm2 c1   ..............................................................................................................
M35_kr_sm2 c2   ..............................................................................................................
P1_rs_ms1 c1    ..............................................................................................................
P1_rs_ms1 c2    ..............................................................................................................
P1_rs_ms3 c1    ..............................................................................................................
P1_rs_ms3 c2    ..............................................................................................................
P1_rs_ms3 c3    .................................................................G............................................
P1_rs_ms3 c4    ....................................................................................T.........................
P1_rs_ms3 c5    .................................................................G............................................
P2_rs_nk2       ..............................................................................................................
P3_rs_pr1       ..............................................................................................................
P4_rs_pr2 c1    ..............................................................................................................
P4_rs_pr2 c2    ..........................................................A...................................................
P4_rs_pr2 c3    ..............................................................................................................
P4_rs_pr3 c4    ..............................................................................................................
P4_rs_pr3 c5    ..............................................................................................................
P5_rs_rc1 c1    ..............................................................................................................
P5_rs_rc1 c2    ....................................................................................T.........................
P5_rs_rc1 c3    ..........................................................A...................................................
P5_rs_rc1 c4    ..............................................................................................................
P5_rs_rc1 c5    ..............................................................................................................
P6_rs_rc7       ..............................................................................................................
P7_rs_us1       ..............................................................................................................
P7_rs_us2 c1    ..............................................................................................................
P7_rs_us2 c2    .................................................................G............................................
P7_rs_us2 c3    .................................................................G............................................
P7_rs_us2 c4    ..............................................................................................................
P7_rs_us2 c5    ..............................................................................................................
P9_rs_pr5       ..............................................................................................................
P10_cn_jl1 c1   ..............................................................................................................
P10_cn_jl1 c2   ....................................................................................T.........................
P11_cn_jl3 c1   ..............................................................................................................
P11_cn_jl3 c2   ..............................................................................................................
P11_cn_jl4 c1   ..............................................................................................................
P11_cn_jl4 c2   ..............................................................................................................
P12_cn_sn2 c1   ..........................................................G...................................................
P12_cn_sn2 c2   ..............................................................................................................
P12_cn_sn2 c3   ..............................................................................................................
```

Appendix 1. (Continued).

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                                                                                                                            550
A1_kr_gr1 c1     AATCAGACCCCGTGGCCGCGAAATGCCGCGACGATTGGTGGTGTACGTGGCAGCCTCGTGCCGCCTAACATCGCGTCGCGCCTTCCGTGGCCCTCTGGAGTAAAAAGGAC
P12_cn_sn2 c4    ....................................................................................T.........................
P13_cn_mc1 c1    ..............................................................................................................
P13_cn_mc1 c2    ...................................................G..........................................................
P13_cn_mc1 c3    ..............................................................................................................
P13_cn_mc2 c1    ..............................................................................................................
P13_cn_mc2 c2    ..............................................................................................................
P13_cn_mc2 c3    ...................................................G..........................................................
P13_cn_mc2 c4    ..............................................................................................................
P14_kr_hw1 c1    ..............................................................................................................
P14_kr_hw1 c2    ..............................................................................................................
P14_kr_hw1 c3    ................T.............................................................................................
P15_kr_dm1 c1    ..............................................................................................................
P15_kr_dm1 c2    ................T.............................................................................................
P15_kr_dm1 c3    ..............................................................................................................
P16_kr_sk2 c1    ................T.............................................................................................
P16_kr_sk2 c2    ..............................................................................................................
P16_kr_sk2 c3    ..............................................................................................................
P16_kr_sk5 c1    ..............................................................................................................
P16_kr_sk5 c2    ................T.............................................................................................
P17_kr_sh1 c1    ..............................................................................................................
P17_kr_sh1 c2    ..............................................................................................................
P17_kr_sh1 c3    ..............................................................................................................
P17_kr_sh1 c4    ..............................................................................................................
P17_kr_sh1 c5    ..............................................................................................................
P17_kr_sh1 c6    ..............................................................................................................
P19_kr_gw1 c1    ..............................................................................................................
P19_kr_gw1 c2    ..............................................................................................................
P19_kr_gw1 c3    ................T.............................................................................................
P19_kr_gw1 c4    ..............................................................................................................
P19_kr_gw3 c1    ..............................................................................................................
P19_kr_gw3 c2    ..............................................................................................................
P19_kr_gw3 c3    ................T.............................................................................................
P20_kr_ck1 c1    ..............................................................................................................
P20_kr_ck1 c2    ..............................................................................................................
P20_kr_ck1 c3    ................T.............................................................................................
P20_kr_ck1 c4    ..............................................................................................................
P20_kr_ck1 c5    ..............................................................................................................
P21_kr_hc1 c1    ..............................................................................................................
P24_kr_mh2 c1    ..............................................................................................................
P24_kr_mh2 c2    ..............................................................................................................
P24_kr_mh2 c3    ..............................................................................................................
P24_kr_mh2 c4    ..............................................................................................................
P21_kr_hc1 c1    ..............................................................................................................
P21_kr_hc1 c2    ..............................................................................................................
P21_kr_hc1 c3    ..............................................................................................................
P21_kr_hc1 c4    ..............................................................................................................
P25_kr_tb1 c1    ..............................................................................................................
P25_kr_tb1 c2    ..............................................................................................................
P25_kr_tb1 c3    ..............................................................................................................
P25_kr_tb1 c4    ................T.............................................................................................
P25_kr_tb1 c5    ..............................................................................................................
P27_kr_so1 c1    ..............................................................................................................
P27_kr_so1 c2    ..............................................................................................................
P27_kr_so1 c3    ..............................................................................................................
P28_kr_il1 c1    ..............................................................................................................
P28_kr_il1 c2    ..............................................................................................................
P28_kr_il1 c3    ..............................................................................................................
P28_kr_il1 c4    ..............................................................................................................
P28_kr_il1 c5    ..............................................................................................................
P29_kr_mj1 c1    ..............................................................................................................
P29_kr_mj1 c2    ..............................................................................................................
P29_kr_mj1 c3    ..............................................................................................................
P29_kr_mj2       ..............................................................................................................
P30_kr_dk1 c1    ..............................................................................................................
P30_kr_dk1 c2    ..............................................................................................................
P30_kr_dk1 c3    ..............................................................................................................
P30_kr_dk1 c4    ..............................................................................................................
P31_kr_jr1 c1    ..............................................................................................................
P31_kr_jr1 c2    ..............................................................................................................
```

Appendix 1. (Continued).

```
                                                                                                                         550
A1_kr_gr1 c1     AATCAGACCCCGTGGCCGCGAAATGCCGCGACGATTGGTGGTGTACGTGGCAGCCTCGTGCCGCCTAACATCGCGTCGCGCCTTCCGTGGCCCTCTGGAGTAAAAAGGAC
P31_kr_jr1 c3    ..............................................................................................................
O1_jp_rb1 c1     ..............................................................................................................
O1_jp_rb1 c2     .................................................................G............................................
O1_jp_rb1 c3     ..............................................................................................................
O1_jp_rb1 c4     ..............................................................................................................
O1_jp_rb1 c5     ..............................................................................................................
O1_jp_rb1 c6     .................................................................G............................................
O2_jp_hk2 c1     .................................................................G............................................
O2_jp_hk2 c2     ..............................................................................................................
O2_jp_hk2 c3     .................................................................G............................................
O2_jp_hk2 c4     .................................................................G............................................
J1_jp_hn2        ..............................................................................................................
B1_cn_bj1        ..............................................................................................................
B2_uk_1          ..............................................................................................................
SUF_hl_1         ....................G..........................CA..G......C.Y..T.G.........C...........C...............-M.....
SUF_hl_2         ....................G..........................CA..G......C.Y..T.G.........C...........C...............-M.....
AMP_cn1          ..........................................--..T.A..G...........T.G.G............T..............G.......-......
```

Appendix 1. (Continued).

```
                                                       593
A1_kr_gr1 c1   CCTCGAGAGCCCTCCGCTGGTGCGGAGGGGCCTCTCAACCGTT
A1_kr_gr1 c2   ...........................................
A2_kr_hl3 c1   ...........................................
A2_kr_hl3 c2   ...........................................
A2_kr_hl5 c1   ...........................................
A2_kr_hl5 c2   ...........................................
A3_kr_hl5 c1   ...........................................
A3_kr_hl5 c2   ...........................................
A4_kr_hl9 c1   ...........................................
A4_kr_hl9 c2   ...........................................
A5_kr_hl10 c1  ...........................................
A5_kr_hl10 c2  ...........................................
A5_kr_hl10 c3  ...........................................
A5_kr_hl10 c4  ...........................................
A5_kr_hl10 c5  ...........................................
A5_kr_hl10 c6  ...........................................
A5_kr_hl11 c1  ...........................................
A5_kr_hl11 c2  ...........................................
A7_mn_1        ...........................................
A8_mn_2 c1     ...........................................
A8_mn_2 c2     ...........................................
M2_rs_kh1 c1   ...........................................
M2_rs_kh1 c2   ...........................................
M2_rs_kh3 c1   ...........................................
M2_rs_kh3 c2   ...........................................
M2_rs_kh3 c3   ...........................................
M2_rs_kh3 c4   ...........................................
M3_rs_kh6 c1   ...........................................
M3_rs_kh6 c2   ...........................................
M3_rs_kh8 c1   ...........................................
M3_rs_kh8 c2   ...........................................
M3_rs_kh20 c1  ...........................................
M3_rs_kh20 c2  ...........................................
M3_rs_kh22 c1  ...........................................
M3_rs_kh23 c1  ...........................................
M3_rs_kh23 c2  ...........................................
M3_rs_kh24     ...........................................
M3_rs_kh25 c1  ...........................................
M3_rs_kh25 c2  ...........................................
M3_rs_kh28 c1  ...........................................
M3_rs_kh28 c2  ...........................................
M3_rs_kh29     ...........................................
M3_rs_kh31 c1  ...........................................
M3_rs_kh31 c2  ...........................................
M3_rs_kh31 c3  ...........................................
M3_rs_kh31_1 c1...........................................
M3_rs_kh31_2 c2...........................................
M4_rs_kh32 c1  ...........................................
M4_rs_kh32 c2  ...........................................
M5_rs_ot1      ...........................................
M6_rs_is2 c1   ...........................................
M6_rs_is2 c2   ...........................................
M7_cn_hj0 c1   ...........................................
M7_cn_hj0 c2   ...........................................
M8_cn_hj3_1 c1 ...........................................
M8_cn_hj3_1 c2 ...........................................
M8_cn_hj2      ...........................................
M8_cn_hj4      ...........................................
M8_cn_hj5 c1   ...........................................
M8_cn_hj5 c2   ...........................................
M9_cn_hj5      ...........................................
M13_kr_od c1   ...........................................
M13_kr_od c2   ...........................................
M13_kr_od c3   ...........................................
M14_kr_jm1 c1  ...........................................
M14_kr_jm1 c2  ...........................................
M16_kr_dr1 c1  ...........................................
M16_kr_dr1 c2  ...........................................
M18_kr_hg1 c1  ...........................................
M18_kr_hg1 c2  ...........................................
```

Appendix 1. (Continued).

```
                                                       593
A1_kr_gr1 c1   CCTCGAGAGCCCTCCGCTGGTGCGGAGGGGCCTCTCAACCGTT
M20_kr_nh1 c1  ...........................................
M20_kr_nh1 c2  ...........................................
M20_kr_nh1 c3  ...........................................
M20_kr_nh1 c4  ...........................................
M21_kr_gu1 c1  ...........................................
M21_kr_gu1 c2  ...........................................
M21_kr_gu1 c3  ...........................................
M21_kr_gu1 c4  ...........................................
M22_kr_mp1 c1  ...........................................
M22_kr_mp1 c2  ...........................................
M25_kr_os2 c1  ...........................................
M25_kr_os2 c2  ...........................................
M25_kr_os3     ...........................................
M25_kr_os4 c1  ...........................................
M25_kr_os4 c2  ...........................................
M28_kr_bs1     ...........................................
M28_kr_bs2 c1  ...........................................
M28_kr_bs2 c2  ...........................................
M28_kr_bs2 c3  ...........................................
M30_kr_bl2 c1  ...........................................
M30_kr_bl2 c2  ...........................................
M32_kr_mt1 c1  ...........................................
M32_kr_mt1 c2  ...........................................
M33_kr_md2 c1  ...........................................
M33_kr_md2 c2  ...........................................
M34_kr_dn1 c1  ...........................................
M34_kr_dn1 c2  ...........................................
M34_kr_dn2 c1  ...........................................
M34_kr_dn2 c2  ...........................................
M35_kr_sm1 c1  ...........................................
M35_kr_sm1 c2  ...........................................
M35_kr_sm2 c1  ...........................................
M35_kr_sm2 c2  ...........................................
P1_rs_ms1 c1   ...........................................
P1_rs_ms1 c2   ...........................................
P1_rs_ms3 c1   ...........................................
P1_rs_ms3 c2   ...........................................
P1_rs_ms3 c3   ...........................................
P1_rs_ms3 c4   ...........................................
P1_rs_ms3 c5   ...........................................
P2_rs_nk2      ...........................................
P3_rs_pr1      ...........................................
P4_rs_pr2 c1   ...........................................
P4_rs_pr2 c2   ...........................................
P4_rs_pr2 c3   ...........................................
P4_rs_pr3 c1   ...........................................
P4_rs_pr3 c2   ...........................................
P5_rs_rc1 c1   ...........................................
P5_rs_rc1 c2   ...........................................
P5_rs_rc1 c3   ...........................................
P5_rs_rc1 c4   ...........................................
P5_rs_rc1 c5   ...........................................
P6_rs_rc7      ...........................................
P7_rs_us1      ...........................................
P7_rs_us2 c1   ...........................................
P7_rs_us2 c2   ...........................................
P7_rs_us2 c3   ...........................................
P7_rs_us2 c4   ...........................................
P7_rs_us2 c5   ...........................................
P9_rs_pr5      ...........................................
P10_cn_jl1 c1  ...........................................
P10_cn_jl1 c2  ...........................................
P11_cn_jl3 c1  ...........................................
P11_cn_jl3 c2  ...........................................
P11_cn_jl4 c1  ...........................................
P11_cn_jl4 c2  ...........................................
P12_cn_sn2 c1  ...........................................
P12_cn_sn2 c2  ...........................................
P12_cn_sn2 c1  ...........................................
```

Appendix 1. (Continued).

```
                                                     593
A1_kr_gr1 c1   CCTCGAGAGCCCTCCGCTGGTGCGGAGGGGCCTCTCAACCGTT
P12_cn_sn2 c2  ...........................................
P13_cn_mc1 c1  ...........................................
P13_cn_mc1 c2  ...........................................
P13_cn_mc1 c3  ...........................................
P13_cn_mc2 c1  ...........................................
P13_cn_mc2 c2  ...........................................
P13_cn_mc2 c3  ...........................................
P13_cn_mc2 c4  ...........................................
P14_kr_hw1 c1  ...........................................
P14_kr_hw1 c2  ...........................................
P14_kr_hw1 c3  ...........................................
P15_kr_dm1 c1  ...........................................
P15_kr_dm1 c2  ...........................................
P15_kr_dm1 c3  ...........................................
P16_kr_sk2 c1  ...........................................
P16_kr_sk2 c2  ...........................................
P16_kr_sk2 c3  ...........................................
P16_kr_sk5 c1  ...........................................
P16_kr_sk5 c2  ...........................................
P17_kr_sh1 c1  ...........................................
P17_kr_sh1 c2  ...........................................
P17_kr_sh1 c3  ...........................................
P17_kr_sh1 c4  ...........................................
P17_kr_sh1 c5  ...........................................
P17_kr_sh1 c6  ...........................................
P19_kr_gw3 c1  ...........................................
P19_kr_gw3 c2  ...........................................
P19_kr_gw3 c3  ...........................................
P19_kr_gw1 c1  ...........................................
P19_kr_gw1 c2  ...........................................
P19_kr_gw1 c3  ...........................................
P19_kr_gw1 c4  ...........................................
P20_kr_ck1 c1  ...........................................
P20_kr_ck1 c2  ...........................................
P20_kr_ck1 c3  ...........................................
P20_kr_ck1 c4  ...........................................
P20_kr_ck1 c5  ...........................................
P21_kr_hc1     ...........................................
P24_kr_mh2 c1  ...........................................
P24_kr_mh2 c2  ...........................................
P24_kr_mh2 c3  ...........................................
P24_kr_mh2 c4  ...........................................
P21_kr_hc1 c1  ...........................................
P21_kr_hc1 c2  ...........................................
P21_kr_hc1 c3  ...........................................
P21_kr_hc1 c4  ...........................................
P25_kr_tb1 c1  ...........................................
P25_kr_tb1 c2  ...........................................
P25_kr_tb1 c3  ...........................................
P25_kr_tb1 c4  ...........................................
P25_kr_tb1 c5  ...........................................
P27_kr_so1 c1  ...........................................
P27_kr_so1 c2  ...........................................
P27_kr_so1 c3  ...........................................
P28_kr_il1 c1  ...........................................
P28_kr_il1 c2  ...........................................
P28_kr_il1 c3  ...........................................
P28_kr_il1 c4  ...........................................
P28_kr_il1 c5  ...........................................
P29_kr_mj1 c1  ...........................................
P29_kr_mj1 c2  ...........................................
P29_kr_mj1 c3  ...........................................
P29_kr_mj2     ...........................................
P30_kr_dk1 c1  ...........................................
P30_kr_dk1 c2  ...........................................
P30_kr_dk1 c3  ...........................................
P30_kr_dk1 c4  ...........................................
P31_kr_jr1 c1  ...........................................
P31_kr_jr1 c2  ...........................................
```

Appendix 1. (Continued).

```
                                                      593
A1_kr_gr1 c1  CCTCGAGAGCCCTCCGCTGGTGCGGAGGGGCCTCTCAACCGTT
P31_kr_jr1 c3 ...........................................
O1_jp_rb1 c1  ...........................................
O1_jp_rb1 c2  ...........................................
O1_jp_rb1 c3  ...........................................
O1_jp_rb1 c4  ...........................................
O1_jp_rb1 c5  ...........................................
O1_jp_rb1 c6  ...........................................
O2_jp_hk2 c1  ...........................................
O2_jp_hk2 c2  ...........................................
O2_jp_hk2 c3  ...........................................
O2_jp_hk2 c4  ...........................................
J1_jp_hn2     ...........................................
B1_cn_bj1     ...........................................
B2_uk_1       ...........................................
SUF_hl_1      ............C....C.........................
SUF_hl_2      ............C....C.........................
AMP_cn1       ........A...C.....A........................
```

Appendix 2.

Aligned sequences of combined cpDNA *trnK* (1–677 bp), *matK* (678–1810 bp) and *ndhF* (1811–3803 bp) regions from taxa of the *B. manshuriensis* complex and related taxa. See Table 4 for acronyms. Dashes (-) indicate gaps and dots (.) indicate matched sequences to the first taxon.

```
                                                                                                                                 120
A1_kr_gr1      AGACTATCAGTAGAGTTTGTAAGACCACGACTGATCCTGAAAGGAATGAATGGAAAAAAGAGCATGTCGTATCAACGTAGAATTATTTTCAACTTTCGTTCTTATTAGATCAGTAAAAAA
A1_kr_gr2      ........................................................................................................................
A2_kr_hl1      ........................................................................................................................
A2_kr_hl2      ........................................................................................................................
A2_kr_hl3      ........................................................................................................................
A2_kr_hl4      ........................................................................................................................
A3_kr_hl5      ........................................................................................................................
A3_kr_hl6      ........................................................................................................................
A3_kr_hl7      ........................................................................................................................
A3_kr_hl8      ........................................................................................................................
A4_kr_hl9      ........................................................................................................................
A5_kr_hl10     ........................................................................................................................
A5_kr_hl11     ........................................................................................................................
A5_kr_hl12     ........................................................................................................................
A5_kr_hl13     ........................................................................................................................
A5_kr_hl14     ........................................................................................................................
A7_mn_1        ........................................................................................................................
A8_mn_2        ........................................................................................................................
M1_rs_kb1      ........................................................................................................................
M2_rs_kh1      ........................................................................................................................
M2_rs_kh2      ........................................................................................................................
M2_rs_kh3      ........................................................................................................................
M3_rs_kh4      ........................................................................................................................
M3_rs_kh5      ........................................................................................................................
M3_rs_kh6      ........................................................................................................................
M3_rs_kh7      ........................................................................................................................
M3_rs_kh8      ........................................................................................................................
M3_rs_kh9      ........................................................................................................................
M3_rs_kh10     ........................................................................................................................
M3_rs_kh11     ........................................................................................................................
M3_rs_kh12     ........................................................................................................................
M3_rs_kh13     ........................................................................................................................
M3_rs_kh14     ........................................................................................................................
M3_rs_kh15     ........................................................................................................................
M3_rs_kh16     ........................................................................................................................
M3_rs_kh17     ........................................................................................................................
M3_rs_kh18     ........................................................................................................................
M3_rs_kh19     ........................................................................................................................
M3_rs_kh20     ........................................................................................................................
M3_rs_kh21     ........................................................................................................................
M3_rs_kh22     ........................................................................................................................
M3_rs_kh23     ........................................................................................................................
M3_rs_kh24     ........................................................................................................................
M3_rs_kh25     ........................................................................................................................
M3_rs_kh26     ........................................................................................................................
M3_rs_kh27     ........................................................................................................................
M3_rs_kh28     ........................................................................................................................
M3_rs_kh29     ........................................................................................................................
M3_rs_kh30     ........................................................................................................................
M3_rs_kh31     ........................................................................................................................
M4_rs_kh32     ........................................................................................................................
M5_rs_ot1      ........................................................................................................................
M6_rs_ri1      ........................................................................................................................
M6_rs_ri2      ........................................................................................................................
M7_cn_hj1      ........................................................................................................................
M8_cn_hj2      ........................................................................................................................
M8_cn_hj3      ........................................................................................................................
M8_cn_hj4      ........................................................................................................................
M9_cn_hj5      ........................................................................................................................
M10_cn_nm1     ........................................................................................................................
M11_cn_ul1     ........................................................................................................................
M12_cn_sb1     ........................................................................................................................
M12_cn_sb2     ........................................................................................................................
M13_kr_od1     ........................................................................................................................
M14_kr_jm1     ........................................................................................................................
M14_kr_jm2     ........................................................................................................................
M14_kr_jm3     ........................................................................................................................
M15_kr_dg1     ........................................................................................................................
M16_kr_dr1     ........................................................................................................................
M17_kr_sw1     ........................................................................................................................
M17_kr_sw2     ........................................................................................................................
M18_kr_hg1     ........................................................................................................................
M19_kr_gy1     ........................................................................................................................
M20_kr_nh1     ........................................................................................................................
M20_kr_nh2     ........................................................................................................................
M21_kr_gu1     ........................................................................................................................
M22_kr_mp1     ........................................................................................................................
M23_kr_bc1     ........................................................................................................................
M24_kr_os1     ........................................................................................................................
M25_kr_os2     ........................................................................................................................
M25_kr_os3     ........................................................................................................................
M25_kr_os4     ........................................................................................................................
M25_kr_os5     ........................................................................................................................
M26_kr_sn1     ........................................................................................................................
M27_kr_gn1     ........................................................................................................................
M27_kr_gn2     ........................................................................................................................
```

Appendix 2. (Continued).

```
                                                                                                                             120
A1_kr_gr1      AGACTATCAGTAGAGTTTGTAAGACCACGACTGATCCTGAAAGGAATGAATGGAAAAAAGAGCATGTCGTATCAACGTAGAATTATTTTCAACTTTCGTTCTTATTAGATCAGTAAAAAA
M28_kr_bs1     ........................................................................................................................
M28_kr_bs2     ........................................................................................................................
M28_kr_bs3     ........................................................................................................................
M29_kr_jn1     ........................................................................................................................
M30_kr_bl1     ........................................................................................................................
M30_kr_bl2     ........................................................................................................................
M31_kr_jl1     ........................................................................................................................
M31_kr_jl2     ........................................................................................................................
M32_kr_mt1     ........................................................................................................................
M33_kr_md1     ........................................................................................................................
M33_kr_md2     ........................................................................................................................
M34_kr_dn1     ........................................................................................................................
M34_kr_dn2     ........................................................................................................................
M35_kr_sm1     ........................................................................................................................
M35_kr_sm2     ........................................................................................................................
P1_rs_ms1      ........................................................................................................................
P1_rs_ms2      ........................................................................................................................
P1_rs_ms3      ........................................................................................................................
P1_rs_ms4      ........................................................................................................................
P2_rs_nk1      ........................................................................................................................
P2_rs_nk2      ........................................................................................................................
P3_rs_pr1      ........................................................................................................................
P4_rs_pr2      ........................................................................................................................
P4_rs_pr3      ........................................................................................................................
P5_rs_rc1      ........................................................................................................................
P5_rs_rc2      ........................................................................................................................
P5_rs_rc3      ........................................................................................................................
P6_rs_rc4      ........................................................................................................................
P6_rs_rc5      ........................................................................................................................
P6_rs_rc6      ........................................................................................................................
P6_rs_rc7      ........................................................................................................................
P6_rs_rc8      ........................................................................................................................
P7_rs_us1      ........................................................................................................................
P7_rs_us2      ........................................................................................................................
P8_rs_pr4      ........................................................................................................................
P9_rs_pr5      ........................................................................................................................
P10_cn_jl1     ........................................................................................................................
P10_cn_jl2     ........................................................................................................................
P11_cn_jl3     ........................................................................................................................
P11_cn_jl4     ........................................................................................................................
P12_cn_sn1     ........................................................................................................................
P12_cn_sn2     ........................................................................................................................
P13_cn_mc1     ........................................................................................................................
P13_cn_mc2     ........................................................................................................................
P14_kr_hw1     ........................................................................................................................
P14_kr_hw2     ........................................................................................................................
P15_kr_dm1     ........................................................................................................................
P15_kr_dm2     ........................................................................................................................
P15_kr_dm3     ........................................................................................................................
P16_kr_sk1     ........................................................................................................................
P16_kr_sk2     ........................................................................................................................
P16_kr_sk3     ........................................................................................................................
P16_kr_sk4     ........................................................................................................................
P16_kr_sk5     ........................................................................................................................
P16_kr_sk6     ........................................................................................................................
P16_kr_sk7     ........................................................................................................................
P16_kr_sk8     ........................................................................................................................
P17_kr_sh1     ........................................................................................................................
P18_kr_gb1     ........................................................................................................................
P19_kr_gw1     ........................................................................................................................
P19_kr_gw2     ........................................................................................................................
P19_kr_gw3     ........................................................................................................................
P20_kr_ck1     ........................................................................................................................
P20_kr_ck2     ........................................................................................................................
P21_kr_hc1     ........................................................................................................................
P22_kr_hb1     ........................................................................................................................
P23_kr_hb2     ........................................................................................................................
P24_kr_mh1     ........................................................................................................................
P24_kr_mh2     ........................................................................................................................
P25_kr_tb1     ........................................................................................................................
P25_kr_tb2     ........................................................................................................................
P26_kr_tb3     ........................................................................................................................
P27_kr_so1     ........................................................................................................................
P27_kr_so2     ........................................................................................................................
P27_kr_so3     ........................................................................................................................
P27_kr_so4     ........................................................................................................................
P27_kr_so5     ........................................................................................................................
P27_kr_so6     ........................................................................................................................
P28_kr_il1     .......................................................................................................................
P29_kr_mj1     ........................................................................................................................
P29_kr_mj2     ........................................................................................................................
P30_kr_dk1     ........................................................................................................................
P31_kr_jr1     ........................................................................................................................
P32_kr_jr2     ........................................................................................................................
O1_jp_rb1      ........................................................................................................................
O2_jp_hk1      ........................................................................................................................
O2_jp_hk2      ........................................................................................................................
O2_jp_hk3      ........................................................................................................................
O2_jp_hk4      ........................................................................................................................
J1_jp_hn1      ........................................................................................................................
J1_jp_hn2      ........................................................................................................................
J2_jp_ky1      ........................................................................................................................
J3_jp_jp1      ........................................................................................................................
B1_cn_bj1      ........................................................................................................................
B2_uk_1        ........................................................................................................................
AMP_cn_1       ...........................................................................-------..................T...................
SUF_kr_hl1     ........................................................................................................................
SUF_kr_hl2     ........................................................................................................................
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Appendix 2. (Continued).

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                                                                                                                                    240
A1_kr_gr1      CTTGGATTAAATTTTTAGAACGAAATGAGTTCAAAATTGGGTCGATTGAATACATGGATCGAGCCTTATGGCTCTAATTGTAGGGAAAGAAAAAGCAACGAGCTTATGTTCTTCGTTGGA
A1_kr_gr2      .......C................................................................................................................
A2_kr_hl1      ........................................................................................................................
A2_kr_hl2      ........................................................................................................................
A2_kr_hl3      ........................................................................................................................
A2_kr_hl4      ........................................................................................................................
A3_kr_hl5      ........................................................................................................................
A3_kr_hl6      ........................................................................................................................
A3_kr_hl7      ........................................................................................................................
A3_kr_hl8      ........................................................................................................................
A4_kr_hl9      ........................................................................................................................
A5_kr_hl10     .......C................................................................................................................
A5_kr_hl11     .......C................................................................................................................
A5_kr_hl12     ........................................................................................................................
A5_kr_hl13     .......C................................................................................................................
A5_kr_hl14     .......C................................................................................................................
A7_mn_1        .......C................................................................................................................
A8_mn_2        .......C................................................................................................................
M1_rs_kb1      .......C................................................................................................................
M2_rs_kh1      .......C................................................................................................................
M2_rs_kh2      .......C................................................................................................................
M2_rs_kh3      .......C................................................................................................................
M3_rs_kh4      .......C................................................................................................................
M3_rs_kh5      .......C................................................................................................................
M3_rs_kh6      ........C...............................................................................................................
M3_rs_kh7      ........C...............................................................................................................
M3_rs_kh8      .......C................................................................................................................
M3_rs_kh9      ........C...............................................................................................................
M3_rs_kh10     ........C...............................................................................................................
M3_rs_kh11     ........C...............................................................................................................
M3_rs_kh12     ........C...............................................................................................................
M3_rs_kh13     ........C...............................................................................................................
M3_rs_kh14     ........C...............................................................................................................
M3_rs_kh15     .......C................................................................................................................
M3_rs_kh16     .......C................................................................................................................
M3_rs_kh17     .......C................................................................................................................
M3_rs_kh18     ........C...............................................................................................................
M3_rs_kh19     .......C................................................................................................................
M3_rs_kh20     ........C...............................................................................................................
M3_rs_kh21     .......C................................................................................................................
M3_rs_kh22     .......C................................................................................................................
M3_rs_kh23     ........C...............................................................................................................
M3_rs_kh24     .......C................................................................................................................
M3_rs_kh25     .......C................................................................................................................
M3_rs_kh26     ........C...............................................................................................................
M3_rs_kh27     .......C................................................................................................................
M3_rs_kh28     .......C................................................................................................................
M3_rs_kh29     .......C................................................................................................................
M3_rs_kh30     ........C...............................................................................................................
M3_rs_kh31     .......C................................................................................................................
M4_rs_kh32     .......C................................................................................................................
M5_rs_ot1      ........C...............................................................................................................
M6_rs_ri1      ........C...............................................................................................................
M6_rs_ri2      .......C................................................................................................................
M7_cn_hj1      ........................................................................................................................
M8_cn_hj2      .......C................................................................................................................
M8_cn_hj3      .......C................................................................................................................
M8_cn_hj4      .......C................................................................................................................
M9_cn_hj5      .......C.....................C..........................................................................................
M10_cn_nm1     .......C................................................................................................................
M11_cn_ul1     .......C................................................................................................................
M12_cn_sb1     .......C................................................................................................................
M12_cn_sb2     .......C................................................................................................................
M13_kr_od1     .......C................................................................................................................
M14_kr_jm1     ........C...............................................................................................................
M14_kr_jm2     ........C...............................................................................................................
M14_kr_jm3     ........C...............................................................................................................
M15_kr_dg1     ........................................................................................................................
M16_kr_dr1     .......C................................................................................................................
M17_kr_sw1     ........................................................................................................................
M17_kr_sw2     ........................................................................................................................
M18_kr_hg1     .......C................................................................................................................
M19_kr_gy1     .......C................................................................................................................
M20_kr_nh1     .......CC...............................................................................................................
M20_kr_nh2     .......CC...............................................................................................................
M21_kr_gu1     .......C................................................................................................................
M22_kr_mp1     .......C................................................................................................................
M23_kr_bc1     .......C................................................................................................................
M24_kr_os1     .......C................................................................................................................
M25_kr_os2     .......C................................................................................................................
M25_kr_os3     ........C...............................................................................................................
M25_kr_os4     .......C................................................................................................................
M25_kr_os5     .......C................................................................................................................
M26_kr_sn1     .......C................................................................................................................
M27_kr_gn1     .......C................................................................................................................
M27_kr_gn2     .......C................................................................................................................
M28_kr_bs1     ........C...............................................................................................................
M28_kr_bs2     .......C................................................................................................................
M28_kr_bs3     ........C...............................................................................................................
M29_kr_jn1     .......C................................................................................................................
M30_kr_bl1     .......C................................................................................................................
M30_kr_bl2     ........C...............................................................................................................
M31_kr_jl1     ........C...............................................................................................................
M31_kr_jl2     .......C................................................................................................................
M32_kr_mt1     .......C................................................................................................................
M33_kr_md1     .......C................................................................................................................
M33_kr_md2     .......C................................................................................................................
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Appendix 2. (Continued).

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                                                                                                                                      240
A1_kr_gr1      CTTGGATTAAATTTTTAGAACGAAATGAGTTCAAAATTGGGTCGATTGAATACATGGATCGAGCCTTATGGCTCTAATTGTAGGGAAAGAAAAAGCAACGAGCTTATGTTCTTCGTTGGA
M34_kr_dn1     ........C...............................................................................................................
M34_kr_dn2     ........C...............................................................................................................
M35_kr_sm1     ........C...............................................................................................................
M35_kr_sm2     ........C...............................................................................................................
P1_rs_ms1      ........C...............................................................................................................
P1_rs_ms2      ........C...............................................................................................................
P1_rs_ms3      ........C...............................................................................................................
P1_rs_ms4      ........C...............................................................................................................
P2_rs_nk1      ........C...............................................................................................................
P2_rs_nk2      ........C...............................................................................................................
P3_rs_pr1      ........C...............................................................................................................
P4_rs_pr2      ........C...............................................................................................................
P4_rs_pr3      .........C..............................................................................................................
P5_rs_rc1      .........C..............................................................................................................
P5_rs_rc2      ........C...............................................................................................................
P5_rs_rc3      ........C...............................................................................................................
P6_rs_rc4      .........C..............................................................................................................
P6_rs_rc5      .........C..............................................................................................................
P6_rs_rc6      .........C..............................................................................................................
P6_rs_rc7      .........C..............................................................................................................
P6_rs_rc8      ........C...............................................................................................................
P7_rs_us1      ........C...............................................................................................................
P7_rs_us2      ........C...............................................................................................................
P8_rs_pr4      ........C...............................................................................................................
P9_rs_pr5      .........C..............................................................................................................
P10_cn_jl1     ........C...............................................................................................................
P10_cn_jl2     ........C...............................................................................................................
P11_cn_jl3     ........C...............................................................................................................
P11_cn_jl4     ........C...............................................................................................................
P12_cn_sn1     ........C...............................................................................................................
P12_cn_sn2     ........C...............................................................................................................
P13_cn_mc1     ........C...............................................................................................................
P13_cn_mc2     ........C...............................................................................................................
P14_kr_hw1     ........C...............................................................................................................
P14_kr_hw2     ........C...............................................................................................................
P15_kr_dm1     ........................................................................................................................
P15_kr_dm2     ........................................................................................................................
P15_kr_dm3     ........................................................................................................................
P16_kr_sk1     ........C...............................................................................................................
P16_kr_sk2     ........C...............................................................................................................
P16_kr_sk3     ........C...............................................................................................................
P16_kr_sk4     ........C...............................................................................................................
P16_kr_sk5     ........C...............................................................................................................
P16_kr_sk6     ........C...............................................................................................................
P16_kr_sk7     ........C...............................................................................................................
P16_kr_sk8     ........C...............................................................................................................
P17_kr_sh1     ........................................................................................................................
P18_kr_gb1     ........C...............................................................................................................
P19_kr_gw1     ........C...............................................................................................................
P19_kr_gw2     ........C...............................................................................................................
P19_kr_gw3     ........C...............................................................................................................
P20_kr_ck1     ........C...............................................................................................................
P20_kr_ck2     ........C...............................................................................................................
P21_kr_hc1     ........C...............................................................................................................
P22_kr_hb1     ........C...............................................................................................................
P23_kr_hb2     ........C...............................................................................................................
P24_kr_mh1     ........C...............................................................................................................
P24_kr_mh2     ........C...............................................................................................................
p25_kr_tb1     ........C...............................................................................................................
p25_kr_tb2     ........C...............................................................................................................
P26_kr_tb3     ........C...............................................................................................................
P27_kr_so1     ........C...............................................................................................................
P27_kr_so2     ........C...............................................................................................................
P27_kr_so3     ........C...............................................................................................................
P27_kr_so4     ........C...............................................................................................................
P27_kr_so5     ........C...............................................................................................................
P27_kr_so6     ........C...............................................................................................................
P28_kr_il1     ........C...............................................................................................................
P29_kr_mj1     ........C...............................................................................................................
P29_kr_mj2     ........C...............................................................................................................
P30_kr_dk1     ........C...............................................................................................................
P31_kr_jr1     ........C...............................................................................................................
P32_kr_jr2     ........C...............................................................................................................
O1_jp_rb1      ........C...............................................................................................................
O2_jp_hk1      ........C...............................................................................................................
O2_jp_hk2      ........C...............................................................................................................
O2_jp_hk3      ........C...............................................................................................................
O2_jp_hk4      ........C...............................................................................................................
J1_jp_hn1      ........C...............................................................................................................
J1_jp_hn2      ........C...............................................................................................................
J2_jp_ky1      ........CC..............................................................................................................
J3_jp_jp1      ........C...............................................................................................................
B1_cn_bj1      ........CC..............................................................................................................
B2_uk_1        .........C..............................................................................................................
AMP_cn_1       .....G..................................................................................................................
SUF_kr_hl1     .....G................................................G.................................................................
SUF_kr_hl2     .....G................................................G.................................................................
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Appendix 2. (Continued).

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                                                                                                                                     360
A1_kr_gr1      ACGATCACCCGCGCTAATTAAACGTTAAAAATAGATTAGTGACTGGGGCGGGAAAGGATTTTCCAAGAGTGGATTACCGATTTTTGAGTGAATCCTAACTATATACCCATTTTTCATTAG
A1_kr_gr2      ..................G..................................................................T..................................
A2_kr_hl1      ........................................................................................................................
A2_kr_hl2      ........................................................................................................................
A2_kr_hl3      ........................................................................................................................
A2_kr_hl4      ........................................................................................................................
A3_kr_hl5      ........................................................................................................................
A3_kr_hl6      ........................................................................................................................
A3_kr_hl7      ........................................................................................................................
A3_kr_hl8      ........................................................................................................................
A4_kr_hl9      ........................................................................................................................
A5_kr_hl10     ..................G..................................................................T..................................
A5_kr_hl11     ..................G..................................................................T..................................
A5_kr_hl12     ........................................................................................................................
A5_kr_hl13     ..................G..................................................................T..................................
A5_kr_hl14     ..................G..................................................................T..................................
A7_mn_1        ..................G..................................................................T..................................
A8_mn_2        ..................G..................................................................T..................................
M1_rs_kb1      ..................G..................................................................T..................................
M2_rs_kh1      ..................G..................................................................T..................................
M2_rs_kh2      ..................G..................................................................T..................................
M2_rs_kh3      ..................G..................................................................T..................................
M3_rs_kh4      ..................G..................................................................T..................................
M3_rs_kh5      ..................G..................................................................T..................................
M3_rs_kh6      .....................................................................................T..................................
M3_rs_kh7      .....................................................................................T..................................
M3_rs_kh8      ..................G..................................................................T..................................
M3_rs_kh9      .....................................................................................T..................................
M3_rs_kh10     .....................................................................................T..................................
M3_rs_kh11     .....................................................................................T..................................
M3_rs_kh12     .....................................................................................T..................................
M3_rs_kh13     .....................................................................................T..................................
M3_rs_kh14     .....................................................................................T..................................
M3_rs_kh15     ..................G..................................................................T..................................
M3_rs_kh16     ..................G..................................................................T..................................
M3_rs_kh17     ..................G..................................................................T..................................
M3_rs_kh18     .....................................................................................T..................................
M3_rs_kh19     ..................G..................................................................T..................................
M3_rs_kh20     .....................................................................................T..................................
M3_rs_kh21     ..................G..................................................................T..................................
M3_rs_kh22     ..................G..................................................................T..................................
M3_rs_kh23     .....................................................................................T..................................
M3_rs_kh24     ..................G..................................................................T..................................
M3_rs_kh25     ..................G..................................................................T..................................
M3_rs_kh26     .....................................................................................T..................................
M3_rs_kh27     ..................G..................................................................T..................................
M3_rs_kh28     ..................G..................................................................T..................................
M3_rs_kh29     ..................G..................................................................T..................................
M3_rs_kh30     .....................................................................................T..................................
M3_rs_kh31     ..................G..................................................................T..................................
M4_rs_kh32     ..................G..................................................................T..................................
M5_rs_ot1      .....................................................................................T..................................
M6_rs_ri1      .........................................C...........................................T..................................
M6_rs_ri2      ..................G..................................................................T..................................
M7_cn_hj1      ........................................................................................................................
M8_cn_hj3      ..................G..................................................................T..................................
M8_cn_hj2      ..................G..................................................................T..................................
M8_cn_hj4      ..................G..................................................................T..................................
M9_cn_hj5      ..................G..................................................................T..................................
M10_cn_nm1     ..................G..................................................................T..................................
M11_cn_ul1     ..................G..................................................................T..................................
M12_cn_sb1     ..................G..................................................................T..................................
M12_cn_sb2     ..................G..................................................................T..................................
M13_kr_od1     ..................G..................................................................T..................................
M14_kr_jm1     .....................................................................................T..................................
M14_kr_jm2     .....................................................................................T..................................
M14_kr_jm3     .....................................................................................T..................................
M15_kr_dg1     ........................................................................................................................
M16_kr_dr1     ..................G..................................................................T..................................
M17_kr_sw1     ........................................................................................................................
M17_kr_sw2     ........................................................................................................................
M18_kr_hg1     ..................G..................................................................T..................................
M19_kr_gy1     ..................G..................................................................T..................................
M20_kr_nh1     .....................................................................................T..................................
M20_kr_nh2     .....................................................................................T..................................
M21_kr_gu1     ..................G..................................................................T..................................
M22_kr_mp1     ..................G..................................................................T..................................
M23_kr_bc1     ..................G..................................................................T..................................
M24_kr_os1     ..................G..................................................................T..................................
M25_kr_os2     ..................G..................................................................T..................................
M25_kr_os3     .........................................C...........................................T..................................
M25_kr_os4     ..................G..................................................................T..................................
M25_kr_os5     ..................G..................................................................T..................................
M26_kr_sn1     ..................G..................................................................T..................................
M27_kr_gn1     ..................G..................................................................T..................................
M27_kr_gn2     ..................G..................................................................T..................................
M28_kr_bs1     .....................................................................................T..................................
M28_kr_bs2     ..................G..................................................................T..................................
M28_kr_bs3     .....................................................................................T..................................
M29_kr_jn1     ..................G..................................................................T..................................
M30_kr_bl1     ..................G..................................................................T..................................
M30_kr_bl2     .....................................................................................T..................................
M31_kr_jl1     .....................................................................................T..................................
M31_kr_jl2     ..................G..................................................................T..................................
M32_kr_mt1     ..................G..................................................................T..................................
M33_kr_md1     ..................G..................................................................T..................................
M33_kr_md2     ..................G..................................................................T..................................
```

Appendix 2. (Continued).

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                                                                                                                                            360
A1_kr_gr1       ACGATCACCCGCGCTAATTAAACGTTAAAAATAGATTAGTGACTGGGGCGGGAAAGGATTTTCCAAGAGTGGATTACCGATTTTTGAGTGAATCCTAACTATATACCCATTTTTCATTAG
M34_kr_dn1      ..................G..................................................................T..................................
M34_kr_dn2      ..................G..................................................................T..................................
M35_kr_sm1      ..................G..................................................................T..................................
M35_kr_sm2      ..................G..................................................................T..................................
P1_rs_ms1       ..................G..................................................................T..................................
P1_rs_ms2       ..................G..................................................................T..................................
P1_rs_ms3       ..................G..................................................................T..................................
P1_rs_ms4       ..................G..................................................................T..................................
P2_rs_nk1       ..................G..................................................................T..................................
P2_rs_nk2       ..................G..................................................................T..................................
P3_rs_pr1       ..................G..................................................................T..................................
P4_rs_pr2       ..................G..................................................................T..................................
P4_rs_pr3       .........................................C...........................................T..................................
P5_rs_rc1       .....................................................................................T..................................
P5_rs_rc2       ..................G..................................................................T..................................
P5_rs_rc3       ..................G..................................................................T..................................
P6_rs_rc4       ................C....................................................................T..................................
P6_rs_rc5       ................C....................................................................T..................................
P6_rs_rc6       ................C....................................................................T..................................
P6_rs_rc7       ................C....................................................................T..................................
P6_rs_rc8       ..................G..................................................................T..................................
P7_rs_us1       ..................G..................................................................T..................................
P7_rs_us2       ..................G..................................................................T..................................
P8_rs_pr4       ..................G..................................................................T..................................
P9_rs_pr5       .....................................................................................T..................................
P10_cn_jl1      ..................G..................................................................T..................................
P10_cn_jl2      ..................G..................................................................T..................................
P11_cn_jl3      ..................G..................................................................T..................................
P11_cn_jl4      ..................G..................................................................T..................................
P12_cn_sn1      ..................G..................................................................T..................................
P12_cn_sn2      ..................G..................................................................T..................................
P13_cn_mc1      ..................G..................................................................T..................................
P13_cn_mc2      ..................G..................................................................T..................................
P14_kr_hw1      ..................G..................................................................T..................................
P14_kr_hw2      ..................G..................................................................T..................................
P15_kr_dm1      ........................................................................................................................
P15_kr_dm2      ........................................................................................................................
P15_kr_dm3      ........................................................................................................................
P16_kr_sk1      ..................G..................................................................T..................................
P16_kr_sk2      ..................G..................................................................T..................................
P16_kr_sk3      ..................G..................................................................T..................................
P16_kr_sk4      ..................G..................................................................T..................................
P16_kr_sk5      ..................G..................................................................T..................................
P16_kr_sk6      ..................G..................................................................T..................................
P16_kr_sk7      ..................G..................................................................T..................................
P16_kr_sk8      ..................G..................................................................T..................................
P17_kr_sh1      ........................................................................................................................
P18_kr_gb1      ..................G..................................................................T..................................
P19_kr_gw1      ..................G..................................................................T..................................
P19_kr_gw2      ..................G..................................................................T..................................
P19_kr_gw3      ..................G..................................................................T..................................
P20_kr_ck1      ..................G..................................................................T..................................
P20_kr_ck2      ..................G..................................................................T..................................
P21_kr_hc1      ..................G..................................................................T..................................
P22_kr_hb1      ..................G..................................................................T..................................
P23_kr_hb2      ..................G..................................................................T..................................
P24_kr_mh1      ..................G..................................................................T..................................
P24_kr_mh2      ..................G..................................................................T..................................
p25_kr_tb1      ..................G..................................................................T..................................
p25_kr_tb2      ..................G..................................................................T..................................
P26_kr_tb3      ..................G..................................................................T..................................
P27_kr_so1      ..................G..................................................................T..................................
P27_kr_so2      ..................G..................................................................T..................................
P27_kr_so3      ..................G..................................................................T..................................
P27_kr_so4      ..................G..................................................................T..................................
P27_kr_so5      ..................G..................................................................T..................................
P27_kr_so6      ..................G..................................................................T..................................
P28_kr_il1      ..................G..................................................................T..................................
P29_kr_mj1      ..................G..................................................................T..................................
P29_kr_mj2      ..................G..................................................................T..................................
P30_kr_dk1      ..................G..................................................................T..................................
P31_kr_jr1      ..................G..................................................................T..................................
P32_kr_jr2      ..................G..................................................................T..................................
O1_jp_rb1       ..................G..................................................................T..................................
O2_jp_hk1       ..................G..................................................................T..................................
O2_jp_hk2       ..................G..................................................................T..................................
O2_jp_hk3       ..................G..................................................................T..................................
O2_jp_hk4       ..................G..................................................................T..................................
J1_jp_hn1       ..................G..................................................................T..................................
J1_jp_hn2       ..................G..................................................................T..................................
J2_jp_ky1       .....................................................................................T..................................
J3_jp_jp1       ..................G..................................................................T..................................
B1_cn_bj1       .....................................................................................T..................................
B2_uk_1         .....................................................................................T..................................
AMP_cn_1        .....................................................................................T..........................C.......
SUF_kr_hl1      .....................................................................................T................C.................
SUF_kr_hl2      .....................................................................................T................C.................
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Appendix 2. (Continued).

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                                                                                                                                     480
A1_kr_gr1      ATTAGAAAATGGAGATTAATGTGTAAAAGAAACAGTATATTGATAAGGATACTTTTTTT-CCAAAATCAAAAGAGCGATTGGGTTGAAAAAATAAAGGATTTCTAATCATCTTCTTAACC
A1_kr_gr2      ...........................................................-............................................................
A2_kr_hl1      ...........................................................-............................................................
A2_kr_hl2      ...........................................................-............................................................
A2_kr_hl3      ...........................................................-............................................................
A2_kr_hl4      ...........................................................-............................................................
A3_kr_hl5      ...........................................................-............................................................
A3_kr_hl6      ...........................................................-............................................................
A3_kr_hl7      ...........................................................-............................................................
A3_kr_hl8      ...........................................................-............................................................
A4_kr_hl9      ...........................................................-............................................................
A5_kr_hl10     ...........................................................-............................................................
A5_kr_hl11     ...........................................................-............................................................
A5_kr_hl12     ...........................................................-............................................................
A5_kr_hl13     ...........................................................-............................................................
A5_kr_hl14     ...........................................................-............................................................
A7_mn_1        ....T......................................................-............................................................
A8_mn_2        ...........................................................-............................................................
M1_rs_kb1      ...........................................................-............................................................
M2_rs_kh1      ...........................................................-............................................................
M2_rs_kh2      ...........................................................-............................................................
M2_rs_kh3      ...........................................................-............................................................
M3_rs_kh4      ...........................................................-............................................................
M3_rs_kh5      ...........................................................-............................................................
M3_rs_kh6      ...........................................................-............................................................
M3_rs_kh7      ...........................................................-............................................................
M3_rs_kh8      ...........................................................-............................................................
M3_rs_kh9      ...........................................................-............................................................
M3_rs_kh10     ...........................................................-............................................................
M3_rs_kh11     ...........................................................-............................................................
M3_rs_kh12     ...........................................................-............................................................
M3_rs_kh13     ...........................................................-............................................................
M3_rs_kh14     ...........................................................-............................................................
M3_rs_kh15     ...........................................................-............................................................
M3_rs_kh16     ...........................................................-............................................................
M3_rs_kh17     ...........................................................-............................................................
M3_rs_kh18     ...........................................................-............................................................
M3_rs_kh19     ...........................................................-............................................................
M3_rs_kh20     ...........................................................-............................................................
M3_rs_kh21     ...........................................................-............................................................
M3_rs_kh22     ...........................................................-............................................................
M3_rs_kh23     ...........................................................-............................................................
M3_rs_kh24     ...........................................................-............................................................
M3_rs_kh25     ...........................................................-............................................................
M3_rs_kh26     ...........................................................-............................................................
M3_rs_kh27     ...........................................................-............................................................
M3_rs_kh28     ...........................................................-............................................................
M3_rs_kh29     ...........................................................-............................................................
M3_rs_kh30     ...........................................................-............................................................
M3_rs_kh31     ...........................................................-............................................................
M4_rs_kh32     ...........................................................-............................................................
M5_rs_ot1      ...........................................................-............................................................
M6_rs_ri1      ...........................................................-............................................................
M6_rs_ri2      ...........................................................-............................................................
M7_cn_hj1      ...........................................................-............................................................
M8_cn_hj2      ...........................................................-............................................................
M8_cn_hj3      ...........................................................-............................................................
M8_cn_hj4      ...........................................................-............................................................
M9_cn_hj5      ...........................................................-............................................................
M10_cn_nm1     ...........................................................-............................................................
M11_cn_ul1     ...........................................................-............................................................
M12_cn_sb1     ...........................................................-............................................................
M12_cn_sb2     ...........................................................-............................................................
M13_kr_od1     ...........................................................-............................................................
M14_kr_jm1     ...........................................................-............................................................
M14_kr_jm2     ...........................................................-............................................................
M14_kr_jm3     ...........................................................-............................................................
M15_kr_dg1     ...........................................................-............................................................
M16_kr_dr1     ...........................................................-............................................................
M17_kr_sw1     ...........................................................-............................................................
M17_kr_sw2     ...........................................................-............................................................
M18_kr_hg1     ...........................................................-............................................................
M19_kr_gy1     ...........................................................-............................................................
M20_kr_nh1     ...........................................................-............................................................
M20_kr_nh2     ...........................................................-............................................................
M21_kr_gu1     ...........................................................-............................................................
M22_kr_mp1     ...........................................................-............................................................
M23_kr_bc1     ...........................................................-............................................................
M24_kr_os1     ...........................................................-............................................................
M25_kr_os2     ...........................................................-............................................................
M25_kr_os3     ...........................................................-............................................................
M25_kr_os4     ...........................................................-............................................................
M25_kr_os5     ...........................................................-............................................................
M26_kr_sn1     ...........................................................-............................................................
M27_kr_gn1     ...........................................................-............................................................
M27_kr_gn2     ...........................................................-............................................................
M28_kr_bs1     ...........................................................-............................................................
M28_kr_bs2     ...........................................................-............................................................
M28_kr_bs3     ...........................................................-............................................................
M29_kr_jn1     ...........................................................-............................................................
M30_kr_bl1     ...........................................................-............................................................
M30_kr_bl2     ...........................................................-............................................................
M31_kr_jl1     ...........................................................-.A..........................................................
M31_kr_jl2     ...........................................................-............................................................
M32_kr_mt1     ...........................................................-............................................................
M33_kr_md1     ...........................................................-............................................................
M33_kr_md2     ...........................................................-............................................................
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Appendix 2. (Continued).

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                                                                                                                                   480
A1_kr_gr1      ATTAGAAAATGGAGATTAATGTGTAAAAGAAACAGTATATTGATAAGGATACTTTTTTT-CCAAAATCAAAAGAGCGATTGGGTTGAAAAAATAAAGGATTTCTAATCATCTTCTTAACC
M34_kr_dn1     ...........................................................-............................................................
M34_kr_dn2     ...........................................................-............................................................
M35_kr_sm1     ...........................................................-............................................................
M35_kr_sm2     ...........................................................-............................................................
P1_rs_ms1      ...........................................................-............................................................
P1_rs_ms2      ...........................................................-............................................................
P1_rs_ms3      ...........................................................-............................................................
P1_rs_ms4      ...........................................................-............................................................
P2_rs_nk1      ...........................................................-............................................................
P2_rs_nk2      ...........................................................-............................................................
P3_rs_pr1      ...........................................................-............................................................
P4_rs_pr2      ...........................................................-............................................................
P4_rs_pr3      ...........................................................-............................................................
P5_rs_rc1      ...........................................................-............................................................
P5_rs_rc2      ...........................................................-............................................................
P5_rs_rc3      ...........................................................-............................................................
P6_rs_rc4      ...........................................................-............................................................
P6_rs_rc5      ...........................................................-............................................................
P6_rs_rc6      ...........................................................-............................................................
P6_rs_rc7      ...........................................................-............................................................
P6_rs_rc8      ...........................................................-............................................................
P7_rs_us1      ...........................................................-............................................................
P7_rs_us2      ...........................................................-............................................................
P8_rs_pr4      ...........................................................-............................................................
P9_rs_pr5      ...........................................................-............................................................
P10_cn_jl1     ...........................................................-............................................................
P10_cn_jl2     ...........................................................-............................................................
P11_cn_jl3     ...........................................................-............................................................
P11_cn_jl4     ...........................................................-............................................................
P12_cn_sn1     ...........................................................-............................................................
P12_cn_sn2     ...........................................................-............................................................
P13_cn_mc1     ...........................................................-............................................................
P13_cn_mc2     ...........................................................-............................................................
P14_kr_hw1     ...........................................................-............................................................
P14_kr_hw2     ...........................................................-............................................................
P15_kr_dm1     ...........................................................-............................................................
P15_kr_dm2     ...........................................................-............................................................
P15_kr_dm3     ...........................................................-............................................................
P16_kr_sk1     ...........................................................-............................................................
P16_kr_sk2     ...........................................................-............................................................
P16_kr_sk3     ...........................................................-............................................................
P16_kr_sk4     ...........................................................-............................................................
P16_kr_sk5     ...........................................................-............................................................
P16_kr_sk6     ...........................................................-............................................................
P16_kr_sk7     ...........................................................-............................................................
P16_kr_sk8     ...........................................................-............................................................
P17_kr_sh1     ...........................................................-............................................................
P18_kr_gb1     ...........................................................-............................................................
P19_kr_gw1     ...........................................................-............................................................
P19_kr_gw2     ...........................................................-............................................................
P19_kr_gw3     ...........................................................-............................................................
P20_kr_ck1     ...........................................................-............................................................
P20_kr_ck2     ...........................................................-............................................................
P21_kr_hc1     ...........................................................-............................................................
P22_kr_hb1     ...........................................................-............................................................
P23_kr_hb2     ...........................................................-............................................................
P24_kr_mh1     ...........................................................-............................................................
P24_kr_mh2     ...........................................................-............................................................
p25_kr_tb1     ...........................................................-............................................................
p25_kr_tb2     ...........................................................-............................................................
P26_kr_tb3     ...........................................................-............................................................
P27_kr_so1     ...........................................................-............................................................
P27_kr_so2     ...........................................................-............................................................
P27_kr_so3     ...........................................................-............................................................
P27_kr_so4     ...........................................................-............................................................
P27_kr_so5     ...........................................................-............................................................
P27_kr_so6     ...........................................................-............................................................
P28_kr_il1     ...........................................................-............................................................
P29_kr_mj1     ...........................................................-............................................................
P29_kr_mj2     ...........................................................-............................................................
P30_kr_dk1     ...........................................................-............................................................
P31_kr_jr1     ...........................................................-............................................................
P32_kr_jr2     ...........................................................-............................................................
O1_jp_rb1      ...........................................................-............................................................
O2_jp_hk1      ...........................................................-............................................................
O2_jp_hk2      ...........................................................-............................................................
O2_jp_hk3      ...........................................................-............................................................
O2_jp_hk4      ...........................................................-............................................................
J1_jp_hn1      ...........................................................-............................................................
J1_jp_hn2      ...........................................................-............................................................
J2_jp_ky1      ...........................................................-............................................................
J3_jp_jp1      ...........................................................-............................................................
B1_cn_bj1      ...........................................................-............................................................
B2_uk_1        ...........................................................-............................................................
AMP_cn_1       ...C.......................................................-............................................................
SUF_kr_hl1     ...........................................................T............................................................
SUF_kr_hl2     ...........................................................T............................................................
```

Appendix 2. (Continued).

```
                                                                                                                             600
A1_kr_gr1       TATAACTATCAATAAAGAAACCAATTAGATGCTAGATGGAAAAAAGATAGAGAGTCCGTTGATGAGTTTAGCTGTCTCCAAGGTATCTATCGATTATTTTGTACTAGAATACCTTGTTTT
A1_kr_gr2       ........................................................................................................................
A2_kr_hl1       ........................................................................................................................
A2_kr_hl2       ........................................................................................................................
A2_kr_hl3       ........................................................................................................................
A2_kr_hl4       ........................................................................................................................
A3_kr_hl5       ........................................................................................................................
A3_kr_hl6       ........................................................................................................................
A3_kr_hl7       ........................................................................................................................
A3_kr_hl8       ........................................................................................................................
A4_kr_hl9       ........................................................................................................................
A5_kr_hl10      ........................................................................................................................
A5_kr_hl11      ........................................................................................................................
A5_kr_hl12      ........................................................................................................................
A5_kr_hl13      ........................................................................................................................
A5_kr_hl14      ........................................................................................................................
A7_mn_1         ........................................................................................................................
A8_mn_2         ........................................................................................................................
M1_rs_kb1       ........................................................................................................................
M2_rs_kh1       ........................................................................................................................
M2_rs_kh2       ........................................................................................................................
M2_rs_kh3       ........................................................................................................................
M3_rs_kh4       ........................................................................................................................
M3_rs_kh5       ........................................................................................................................
M3_rs_kh6       ........................................................................................................................
M3_rs_kh7       ........................................................................................................................
M3_rs_kh8       ........................................................................................................................
M3_rs_kh9       ........................................................................................................................
M3_rs_kh10      ........................................................................................................................
M3_rs_kh11      ........................................................................................................................
M3_rs_kh12      ........................................................................................................................
M3_rs_kh13      ........................................................................................................................
M3_rs_kh14      ........................................................................................................................
M3_rs_kh15      ........................................................................................................................
M3_rs_kh16      ........................................................................................................................
M3_rs_kh17      ........................................................................................................................
M3_rs_kh18      ........................................................................................................................
M3_rs_kh19      ........................................................................................................................
M3_rs_kh20      ........................................................................................................................
M3_rs_kh21      ........................................................................................................................
M3_rs_kh22      ........................................................................................................................
M3_rs_kh23      ........................................................................................................................
M3_rs_kh24      ........................................................................................................................
M3_rs_kh25      ........................................................................................................................
M3_rs_kh26      ........................................................................................................................
M3_rs_kh27      ........................................................................................................................
M3_rs_kh28      ........................................................................................................................
M3_rs_kh29      ........................................................................................................................
M3_rs_kh30      ........................................................................................................................
M3_rs_kh31      ........................................................................................................................
M4_rs_kh32      ........................................................................................................................
M5_rs_ot1       ........................................................................................................................
M6_rs_ri1       ........................................................................................................................
M6_rs_ri2       ........................................................................................................................
M7_cn_hj1       ........................................................................................................................
M8_cn_hj2       ........................................................................................................................
M8_cn_hj3       ........................................................................................................................
M8_cn_hj4       ........................................................................................................................
M9_cn_hj5       ........................................................................................................................
M10_cn_nm1      ........................................................................................................................
M11_cn_ul1      ........................................................................................................................
M12_cn_sb1      ........................................................................................................................
M12_cn_sb2      ........................................................................................................................
M13_kr_od1      ........................................................................................................................
M14_kr_jm1      ........................................................................................................................
M14_kr_jm2      ........................................................................................................................
M14_kr_jm3      ........................................................................................................................
M15_kr_dg1      ........................................................................................................................
M16_kr_dr1      ........................................................................................................................
M17_kr_sw1      ........................................................................................................................
M17_kr_sw2      ........................................................................................................................
M18_kr_hg1      ........................................................................................................................
M19_kr_gy1      ........................................................................................................................
M20_kr_nh1      ........................................................................................................................
M20_kr_nh2      ........................................................................................................................
M21_kr_gu1      ........................................................................................................................
M22_kr_mp1      ........................................................................................................................
M23_kr_bc1      ........................................................................................................................
M24_kr_os1      ........................................................................................................................
M25_kr_os2      ........................................................................................................................
M25_kr_os3      ........................................................................................................................
M25_kr_os4      ........................................................................................................................
M25_kr_os5      ........................................................................................................................
M26_kr_sn1      ........................................................................................................................
M27_kr_gn1      ........................................................................................................................
M27_kr_gn2      ........................................................................................................................
M28_kr_bs1      ........................................................................................................................
M28_kr_bs2      ........................................................................................................................
M28_kr_bs3      ........................................................................................................................
M29_kr_jn1      ........................................................................................................................
M30_kr_bl1      ........................................................................................................................
M30_kr_bl2      ........................................................................................................................
M31_kr_jl1      ........................................................................................................................
M31_kr_jl2      ........................................................................................................................
M32_kr_mt1      ........................................................................................................................
M33_kr_md1      ........................................................................................................................
M33_kr_md2      ........................................................................................................................
```

Appendix 2. (Continued).

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                                                                                                                                    720
A1_kr_gr1      TATAACTATCAATAAAGAAACCAATTAGATGCTAGATGGAAAAAAGATAGAGAGTCCGTTGATGAGTTTAGCTGTCTCCAAGGTATCTATCGATTATTTTGTACTAGAATACCTTGTTTT
M34_kr_dn1     ........................................................................................................................
M34_kr_dn2     ........................................................................................................................
M35_kr_sm1     ........................................................................................................................
M35_kr_sm2     ........................................................................................................................
P1_rs_ms1      ........................................................................................................................
P1_rs_ms2      ........................................................................................................................
P1_rs_ms3      ........................................................................................................................
P1_rs_ms4      ........................................................................................................................
P2_rs_nk1      ........................................................................................................................
P2_rs_nk2      ........................................................................................................................
P3_rs_pr1      ........................................................................................................................
P4_rs_pr2      ........................................................................................................................
P4_rs_pr3      ........................................................................................................................
P5_rs_rc1      ........................................................................................................................
P5_rs_rc2      ........................................................................................................................
P5_rs_rc3      ........................................................................................................................
P6_rs_rc4      ........................................................................................................................
P6_rs_rc5      ........................................................................................................................
P6_rs_rc6      ........................................................................................................................
P6_rs_rc7      ........................................................................................................................
P6_rs_rc8      ........................................................................................................................
P7_rs_us1      ........................................................................................................................
P7_rs_us2      ........................................................................................................................
P8_rs_pr4      ........................................................................................................................
P9_rs_pr5      ........................................................................................................................
P10_cn_jl1     ........................................................................................................................
P10_cn_jl2     ........................................................................................................................
P11_cn_jl3     ........................................................................................................................
P11_cn_jl4     ........................................................................................................................
P12_cn_sn1     ........................................................................................................................
P12_cn_sn2     ........................................................................................................................
P13_cn_mc1     ........................................................................................................................
P13_cn_mc2     ........................................................................................................................
P14_kr_hw1     ........................................................................................................................
P14_kr_hw2     ........................................................................................................................
P15_kr_dm1     ........................................................................................................................
P15_kr_dm2     ........................................................................................................................
P15_kr_dm3     ........................................................................................................................
P16_kr_sk1     ........................................................................................................................
P16_kr_sk2     ........................................................................................................................
P16_kr_sk3     ........................................................................................................................
P16_kr_sk4     ........................................................................................................................
P16_kr_sk5     ........................................................................................................................
P16_kr_sk6     ........................................................................................................................
P16_kr_sk7     ........................................................................................................................
P16_kr_sk8     ........................................................................................................................
P17_kr_sh1     ........................................................................................................................
P18_kr_gb1     ........................................................................................................................
P19_kr_gw1     ........................................................................................................................
P19_kr_gw2     ........................................................................................................................
P19_kr_gw3     ........................................................................................................................
P20_kr_ck1     ........................................................................................................................
P20_kr_ck2     ........................................................................................................................
P21_kr_hc1     ........................................................................................................................
P22_kr_hb1     ........................................................................................................................
P23_kr_hb2     ........................................................................................................................
P24_kr_mh1     ........................................................................................................................
P24_kr_mh2     ........................................................................................................................
p25_kr_tb1     ........................................................................................................................
p25_kr_tb2     ........................................................................................................................
P26_kr_tb3     ........................................................................................................................
P27_kr_so1     ........................................................................................................................
P27_kr_so2     ........................................................................................................................
P27_kr_so3     ........................................................................................................................
P27_kr_so4     ........................................................................................................................
P27_kr_so5     ........................................................................................................................
P27_kr_so6     ........................................................................................................................
P28_kr_il1     ........................................................................................................................
P29_kr_mj1     ........................................................................................................................
P29_kr_mj2     ........................................................................................................................
P30_kr_dk1     ........................................................................................................................
P31_kr_jr1     ........................................................................................................................
P32_kr_jr2     ........................................................................................................................
O1_jp_rb1      ........................................................................................................................
O2_jp_hk1      ........................................................................................................................
O2_jp_hk2      ........................................................................................................................
O2_jp_hk3      ........................................................................................................................
O2_jp_hk4      ........................................................................................................................
J1_jp_hn1      ........................................................................................................................
J1_jp_hn2      ........................................................................................................................
J2_jp_ky1      ........................................................................................................................
J3_jp_jp1      .............................................................................................C..........................
B1_cn_bj1      ........................................................................................................................
B2_uk_1        ........................................................................................................................
AMP_cn_1       ............G..................G............-...........................................................................
SUF_kr_hl1     ............G........A......C..G........................................................................................
SUF_kr_hl2     ............G........A......C..G........................................................................................
```

Appendix 2. (Continued).

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                                                                                                                                    720
A1_kr_gr1      GACTGTATCGCACTA-TGTACCATTTTATAATCCACGAAACCCTCTACTTTTCCTTTTGTTTCCAGTTTCATTTTAAATGGAAGAATTCCAAGGATATTTAGAACTCGACAGATCTTGGC
A1_kr_gr2      ...............-........................................................................................................
A2_kr_hl1      ...............-........................................................................................................
A2_kr_hl2      ...............-........................................................................................................
A2_kr_hl3      ...............-........................................................................................................
A2_kr_hl4      ...............-........................................................................................................
A3_kr_hl5      ...............-........................................................................................................
A3_kr_hl6      ...............-........................................................................................................
A3_kr_hl7      ...............-........................................................................................................
A3_kr_hl8      ...............-........................................................................................................
A4_kr_hl9      ...............-........................................................................................................
A5_kr_hl10     ...............-........................................................................................................
A5_kr_hl11     ...............-........................................................................................................
A5_kr_hl12     ...............-........................................................................................................
A5_kr_hl13     ...............-........................................................................................................
A5_kr_hl14     ...............-........................................................................................................
A7_mn_1        ...............-........................................................................................................
A8_mn_2        ...............-........................................................................................................
M1_rs_kb1      ...............-........................................................................................................
M2_rs_kh1      ...............-........................................................................................................
M2_rs_kh2      ...............-........................................................................................................
M2_rs_kh3      ...............-........................................................................................................
M3_rs_kh4      ...............-........................................................................................................
M3_rs_kh5      ...............-........................................................................................................
M3_rs_kh6      ...............-........................................................................................................
M3_rs_kh7      ...............-........................................................................................................
M3_rs_kh8      ...............-........................................................................................................
M3_rs_kh9      ...............-........................................................................................................
M3_rs_kh10     ...............-........................................................................................................
M3_rs_kh11     ...............-........................................................................................................
M3_rs_kh12     ...............-........................................................................................................
M3_rs_kh13     ...............-........................................................................................................
M3_rs_kh14     ...............-........................................................................................................
M3_rs_kh15     ...............-........................................................................................................
M3_rs_kh16     ...............-........................................................................................................
M3_rs_kh17     ...............-........................................................................................................
M3_rs_kh18     ...............-........................................................................................................
M3_rs_kh19     ...............-........................................................................................................
M3_rs_kh20     ...............-........................................................................................................
M3_rs_kh21     ...............-........................................................................................................
M3_rs_kh22     ...............-........................................................................................................
M3_rs_kh23     ...............-........................................................................................................
M3_rs_kh24     ...............-........................................................................................................
M3_rs_kh25     ...............-........................................................................................................
M3_rs_kh26     ...............-........................................................................................................
M3_rs_kh27     ...............-........................................................................................................
M3_rs_kh28     ...............-........................................................................................................
M3_rs_kh29     ...............-........................................................................................................
M3_rs_kh30     ...............-........................................................................................................
M3_rs_kh31     ...............-........................................................................................................
M6_rs_ri1      ...............-........................................................................................................
M6_rs_ri2      ...............-........................................................................................................
M4_rs_kh32     ...............-........................................................................................................
M5_rs_ot1      ...............-........................................................................................................
M7_cn_hj1      ...............-........................................................................................................
M8_cn_hj2      ...............-........................................................................................................
M8_cn_hj3      ...............-........................................................................................................
M8_cn_hj4      ...............-........................................................................................................
M9_cn_hj5      ...............-........................................................................................................
M10_cn_nm1     ...............-........................................................................................................
M11_cn_ul1     ...............-........................................................................................................
M12_cn_sb1     ...............-........................................................................................................
M12_cn_sb2     ...............-........................................................................................................
M13_kr_od1     ...............-........................................................................................................
M14_kr_jm1     ...............-........................................................................................................
M14_kr_jm2     ...............-........................................................................................................
M14_kr_jm3     ...............-........................................................................................................
M15_kr_dg1     ...............-........................................................................................................
M16_kr_dr1     ...............-........................................................................................................
M17_kr_sw1     ...............-........................................................................................................
M17_kr_sw2     ...............-........................................................................................................
M18_kr_hg1     ...............-........................................................................................................
M19_kr_gy1     ...............-........................................................................................................
M20_kr_nh1     ...............-........................................................................................................
M20_kr_nh2     ...............-........................................................................................................
M21_kr_gu1     ...............-........................................................................................................
M22_kr_mp1     ...............-........................................................................................................
M23_kr_bc1     ...............-........................................................................................................
M24_kr_os1     ...............-........................................................................................................
M25_kr_os2     ...............-........................................................................................................
M25_kr_os3     ...............-........................................................................................................
M25_kr_os4     ...............-........................................................................................................
M25_kr_os5     ...............A........................................................................................................
M26_kr_sn1     ...............-........................................................................................................
M27_kr_gn1     ...............-........................................................................................................
M27_kr_gn2     ...............-........................................................................................................
M28_kr_bs1     ...............-........................................................................................................
M28_kr_bs2     ...............-........................................................................................................
M28_kr_bs3     ...............-........................................................................................................
M29_kr_jn1     ...............-........................................................................................................
M30_kr_bl1     ...............-........................................................................................................
M30_kr_bl2     ...............-........................................................................................................
M31_kr_jl1     ...............-........................................................................................................
M31_kr_jl2     ...............-........................................................................................................
M32_kr_mt1     ...............-........................................................................................................
M33_kr_md1     ...............-........................................................................................................
M33_kr_md2     ...............-........................................................................................................
```

Appendix 2. (Continued).

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                                                                                                                                       720
A1_kr_gr1      GACTGTATCGCACTA-TGTACCATTTTATAATCCACGAAACCCTCTACTTTTCCTTTTGTTTCCAGTTTCATTTTAAATGGAAGAATTCCAAGGATATTTAGAACTCGACAGATCTTGGC
M34_kr_dn1     ...............-........................................................................................................
M34_kr_dn2     ...............-........................................................................................................
M35_kr_sm1     ...............-........................................................................................................
M35_kr_sm2     ...............-........................................................................................................
P1_rs_ms1      ...............-........................................................................................................
P1_rs_ms2      ...............-........................................................................................................
P1_rs_ms3      ...............-........................................................................................................
P1_rs_ms4      ...............-........................................................................................................
P2_rs_nk1      ...............-........................................................................................................
P2_rs_nk2      ...............-........................................................................................................
P3_rs_pr1      ...............-........................................................................................................
P4_rs_pr2      ...............-........................................................................................................
P4_rs_pr3      ...............-........................................................................................................
P5_rs_rc1      ...............-........................................................................................................
P5_rs_rc2      ...............-........................................................................................................
P5_rs_rc3      ...............-........................................................................................................
P6_rs_rc4      ...............-........................................................................................................
P6_rs_rc5      ...............-........................................................................................................
P6_rs_rc6      ...............-........................................................................................................
P6_rs_rc7      ...............-........................................................................................................
P6_rs_rc8      ...............-........................................................................................................
P7_rs_us1      ...............-........................................................................................................
P7_rs_us2      ...............-........................................................................................................
P8_rs_pr4      ...............-........................................................................................................
P9_rs_pr5      ...............-........................................................................................................
P10_cn_jl1     ...............-........................................................................................................
P10_cn_jl2     ...............-........................................................................................................
P11_cn_jl3     ...............-........................................................................................................
P11_cn_jl4     ...............-........................................................................................................
P12_cn_sn1     ...............-........................................................................................................
P12_cn_sn2     ...............-........................................................................................................
P13_cn_mc1     ...............-........................................................................................................
P13_cn_mc2     ...............-........................................................................................................
P14_kr_hw1     ...............-........................................................................................................
P14_kr_hw2     ...............-........................................................................................................
P15_kr_dm1     ...............-........................................................................................................
P15_kr_dm2     ...............-........................................................................................................
P15_kr_dm3     ...............-........................................................................................................
P16_kr_sk1     ...............-........................................................................................................
P16_kr_sk2     ...............-........................................................................................................
P16_kr_sk3     ...............-........................................................................................................
P16_kr_sk4     ...............-........................................................................................................
P16_kr_sk5     ...............-........................................................................................................
P16_kr_sk6     ...............-........................................................................................................
P16_kr_sk7     ...............-........................................................................................................
P16_kr_sk8     ...............-........................................................................................................
P17_kr_sh1     ...............-........................................................................................................
P18_kr_gb1     ...............-........................................................................................................
P19_kr_gw1     ...............-........................................................................................................
P19_kr_gw2     ...............-........................................................................................................
P19_kr_gw3     ...............-........................................................................................................
P20_kr_ck1     ...............-........................................................................................................
P20_kr_ck2     ...............-........................................................................................................
P21_kr_hc1     ...............-........................................................................................................
P22_kr_hb1     ...............-........................................................................................................
P23_kr_hb2     ...............-........................................................................................................
P24_kr_mh1     ...............-........................................................................................................
P24_kr_mh2     ...............-........................................................................................................
p25_kr_tb1     ...............-........................................................................................................
p25_kr_tb2     ...............-........................................................................................................
P26_kr_tb3     ...............-........................................................................................................
P27_kr_so1     ...............-........................................................................................................
P27_kr_so2     ...............-........................................................................................................
P27_kr_so3     ...............-........................................................................................................
P27_kr_so4     ...............-........................................................................................................
P27_kr_so5     ...............-........................................................................................................
P27_kr_so6     ...............-........................................................................................................
P28_kr_il1     ...............-........................................................................................................
P29_kr_mj1     ...............-........................................................................................................
P29_kr_mj2     ...............-........................................................................................................
P30_kr_dk1     ...............-........................................................................................................
P31_kr_jr1     ...............-........................................................................................................
P32_kr_jr2     ...............-........................................................................................................
O1_jp_rb1      ...............-........................................................................................................
O2_jp_hk1      ...............-........................................................................................................
O2_jp_hk2      ...............-........................................................................................................
O2_jp_hk3      ...............-........................................................................................................
O2_jp_hk4      ...............-........................................................................................................
J1_jp_hn1      ...............-........................................................................................................
J1_jp_hn2      ...............-........................................................................................................
J2_jp_ky1      ...............-........................................................................................................
J3_jp_jp1      ...............-........................................................................................................
B1_cn_bj1      ...............-........................................................................................................
B2_uk_1        ...............-........................................................................................................
AMP_cn_1       ...............-......................................................G...........................................T.....
SUF_kr_hl1     ...............-........................................................................................................
SUF_kr_hl2     ...............-........................................................................................................
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Appendix 2. (Continued).

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                                                                                                                                     840
A1_kr_gr1      AAGACGATTTTTTATATCCACTTCTCTTTCAGGAATATATTTATGCACTTGTACACGATCAGGATTTATATTTAAATAGGCCCGTTTTATTGTCAAATACAAAAAAAAGGGGTGATGACA
A1_kr_gr2      ........................................................................................................................
A2_kr_hl1      ........................................................................................................................
A2_kr_hl2      ........................................................................................................................
A2_kr_hl3      .....................................................................................................................G..
A2_kr_hl4      ........................................................................................................................
A3_kr_hl5      ........................................................................................................................
A3_kr_hl6      .....................................................................................................................G..
A3_kr_hl7      ........................................................................................................................
A3_kr_hl8      ........................................................................................................................
A4_kr_hl9      ........................................................................................................................
A5_kr_hl10     ........................................................................................................................
A5_kr_hl11     .....................................................................................................................G..
A5_kr_hl12     ........................................................................................................................
A5_kr_hl13     .....................................................................................................................G..
A5_kr_hl14     ........................................................................................................................
A7_mn_1        ........................................................................................................................
A8_mn_2        ........................................................................................................................
M1_rs_kb1      ........................................................................................................................
M2_rs_kh1      ........................................................................................................................
M2_rs_kh2      ........................................................................................................................
M2_rs_kh3      ........................................................................................................................
M3_rs_kh4      ........................................................................................................................
M3_rs_kh5      ........................................................................................................................
M3_rs_kh6      ........................................................................................................................
M3_rs_kh7      ........................................................................................................................
M3_rs_kh8      ........................................................................................................................
M3_rs_kh9      ........................................................................................................................
M3_rs_kh10     ........................................................................................................................
M3_rs_kh11     ........................................................................................................................
M3_rs_kh12     ........................................................................................................................
M3_rs_kh13     ........................................................................................................................
M3_rs_kh14     ........................................................................................................................
M3_rs_kh15     ........................................................................................................................
M3_rs_kh16     ........................................................................................................................
M3_rs_kh17     ........................................................................................................................
M3_rs_kh18     ........................................................................................................................
M3_rs_kh19     ........................................................................................................................
M3_rs_kh20     ........................................................................................................................
M3_rs_kh21     ........................................................................................................................
M3_rs_kh22     ........................................................................................................................
M3_rs_kh23     ........................................................................................................................
M3_rs_kh24     ........................................................................................................................
M3_rs_kh25     ........................................................................................................................
M3_rs_kh26     ........................................................................................................................
M3_rs_kh27     ........................................................................................................................
M3_rs_kh28     ........................................................................................................................
M3_rs_kh29     ........................................................................................................................
M3_rs_kh30     ........................................................................................................................
M3_rs_kh31     ........................................................................................................................
M4_rs_kh32     ........................................................................................................................
M5_rs_ot1      ...................................................................................................A.......G............
M6_rs_ri1      .............................................................................................T..........................
M6_rs_ri2      ........................................................................................................................
M7_cn_hj1      ........................................................................................................................
M8_cn_hj2      ........................................................................................................................
M8_cn_hj3      ........................................................................................................................
M8_cn_hj4      ........................................................................................................................
M9_cn_hj5      ........................................................................................................................
M10_cn_nm1     ........................................................................................................................
M11_cn_ul1     ........................................................................................................................
M12_cn_sb1     ........................................................................................................................
M12_cn_sb2     ........................................................................................................................
M13_kr_od1     ........................................................................................................................
M14_kr_jm1     ........................................................................................................................
M14_kr_jm2     ........................................................................................................................
M14_kr_jm3     ........................................................................................................................
M15_kr_dg1     ........................................................................................................................
M16_kr_dr1     ........................................................................................................................
M17_kr_sw1     ........................................................................................................................
M17_kr_sw2     ........................................................................................................................
M18_kr_hg1     ........................................................................................................................
M19_kr_gy1     ........................................................................................................................
M20_kr_nh1     ........................................................................................................................
M20_kr_nh2     ........................................................................................................................
M21_kr_gu1     ........................................................................................................................
M22_kr_mp1     ........................................................................................................................
M23_kr_bc1     ........................................................................................................................
M24_kr_os1     ........................................................................................................................
M25_kr_os2     ........................................................................................................................
M25_kr_os3     ........................................................................................................................
M25_kr_os4     ........................................................................................................................
M25_kr_os5     ........................................................................................................................
M26_kr_sn1     ........................................................................................................................
M27_kr_gn1     ........................................................................................................................
M27_kr_gn2     ........................................................................................................................
M28_kr_bs1     ........................................................................................................................
M28_kr_bs2     ........................................................................................................................
M28_kr_bs3     ........................................................................................................................
M29_kr_jn1     ........................................................................................................................
M30_kr_bl1     ........................................................................................................................
M30_kr_bl2     ........................................................................................................................
M31_kr_jl1     ........................................................................................................................
M31_kr_jl2     ........................................................................................................................
M32_kr_mt1     ........................................................................................................................
M33_kr_md1     .....................................................................................................................G..
M33_kr_md2     .....................................................................................................................G..
```

Appendix 2. (Continued).

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                                                                                                                                    840
A1_kr_gr1      AAGACGATTTTTTATATCCACTTCTCTTTCAGGAATATATTTATGCACTTGTACACGATCAGGATTTATATTTAAATAGGCCCGTTTTATTGTCAAATACAAAAAAAAGGGGTGATGACA
M34_kr_dn1     ........................................................................................................................
M34_kr_dn2     ........................................................................................................................
M35_kr_sm1     ........................................................................................................................
M35_kr_sm2     ........................................................................................................................
P1_rs_ms1      ........................................................................................................................
P1_rs_ms2      ........................................................................................................................
P1_rs_ms3      ........................................................................................................................
P1_rs_ms4      ........................................................................................................................
P2_rs_nk1      ........................................................................................................................
P2_rs_nk2      ........................................................................................................................
P3_rs_pr1      ........................................................................................................................
P4_rs_pr2      ........................................................................................................................
P4_rs_pr3      .............................................................................................T..........................
P5_rs_rc1      ...................................................................................................A.......G............
P5_rs_rc2      ........................................................................................................................
P5_rs_rc3      ........................................................................................................................
P6_rs_rc4      ........................................................................................................................
P6_rs_rc5      ........................................................................................................................
P6_rs_rc6      ........................................................................................................................
P6_rs_rc7      ........................................................................................................................
P6_rs_rc8      ........................................................................................................................
P7_rs_us1      ........................................................................................................................
P7_rs_us2      ........................................................................................................................
P8_rs_pr4      ........................................................................................................................
P9_rs_pr5      ...................................................................................................A.......G............
P10_cn_jl1     ........................................................................................................................
P10_cn_jl2     ........................................................................................................................
P11_cn_jl3     ........................................................................................................................
P11_cn_jl4     ........................................................................................................................
P12_cn_sn1     ........................................................................................................................
P12_cn_sn2     ........................................................................................................................
P13_cn_mc1     ........................................................................................................................
P13_cn_mc2     ........................................................................................................................
P14_kr_hw1     ........................................................................................................................
P14_kr_hw2     ........................................................................................................................
P15_kr_dm1     ........................................................................................................................
P15_kr_dm2     ........................................................................................................................
P15_kr_dm3     ........................................................................................................................
P16_kr_sk1     ........................................................................................................................
P16_kr_sk2     ........................................................................................................................
P16_kr_sk3     ........................................................................................................................
P16_kr_sk4     ........................................................................................................................
P16_kr_sk5     ........................................................................................................................
P16_kr_sk6     ........................................................................................................................
P16_kr_sk7     ........................................................................................................................
P16_kr_sk8     ........................................................................................................................
P17_kr_sh1     ........................................................................................................................
P18_kr_gb1     ........................................................................................................................
P19_kr_gw1     ........................................................................................................................
P19_kr_gw2     ........................................................................................................................
P19_kr_gw3     ........................................................................................................................
P20_kr_ck1     ........................................................................................................................
P20_kr_ck2     ........................................................................................................................
P21_kr_hc1     ........................................................................................................................
P22_kr_hb1     ........................................................................................................................
P23_kr_hb2     ........................................................................................................................
P24_kr_mh1     ........................................................................................................................
P24_kr_mh2     ........................................................................................................................
p25_kr_tb1     ........................................................................................................................
p25_kr_tb2     ........................................................................................................................
P26_kr_tb3     ........................................................................................................................
P27_kr_so1     ........................................................................................................................
P27_kr_so2     ........................................................................................................................
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P27_kr_so4     ........................................................................................................................
P27_kr_so5     ........................................................................................................................
P27_kr_so6     ........................................................................................................................
P28_kr_il1     ........................................................................................................................
P29_kr_mj1     ........................................................................................................................
P29_kr_mj2     ........................................................................................................................
P30_kr_dk1     ........................................................................................................................
P31_kr_jr1     ........................................................................................................................
P32_kr_jr2     ........................................................................................................................
O1_jp_rb1      ........................................................................................................................
O2_jp_hk1      ........................................................................................................................
O2_jp_hk2      ........................................................................................................................
O2_jp_hk3      ........................................................................................................................
O2_jp_hk4      ........................................................................................................................
J1_jp_hn1      ........................................................................................................................
J1_jp_hn2      ........................................................................................................................
J2_jp_ky1      ........................................................................................................................
J3_jp_jp1      ........................................................................................................................
B1_cn_bj1      ........................................................................................................................
B2_uk_1        ........................................................................................................................
AMP_cn_1       .......................A................................................................................................
SUF_kr_hl1     .......................A................................................................G...............................
SUF_kr_hl2     .......................A................................................................G...............................
```

Appendix 2. (Continued).

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                                                                                                                                     960
A1_kr_gr1      CAAAGTACAGTTTACTAGTTGTAAGACGTTTAGTTATTCGAATGTATCAACAGAATCATTCGATTCTTTCTGTTAATGATTCTAATAAAAATAAATTTATTGTACTCCCCCAAAATTTGT
A1_kr_gr2      ........................................................................................................................
A2_kr_hl1      ........................................................................................................................
A2_kr_hl2      ........................................................................................................................
A2_kr_hl3      ........................................................................................................................
A2_kr_hl4      ........................................................................................................................
A3_kr_hl5      ........................................................................................................................
A3_kr_hl6      ........................................................................................................................
A3_kr_hl7      ........................................................................................................................
A3_kr_hl8      ........................................................................................................................
A4_kr_hl9      ........................................................................................................................
A5_kr_hl10     ........................................................................................................................
A5_kr_hl11     ........................................................................................................................
A5_kr_hl12     ........................................................................................................................
A5_kr_hl13     ........................................................................................................................
A5_kr_hl14     ........................................................................................................................
A7_mn_1        ........................................................................................................................
A8_mn_2        ........................................................................................................................
M1_rs_kb1      ........................................................................................................................
M2_rs_kh1      ........................................................................................................................
M2_rs_kh2      ........................................................................................................................
M2_rs_kh3      ........................................................................................................................
M3_rs_kh4      ........................................................................................................................
M3_rs_kh5      ........................................................................................................................
M3_rs_kh6      ........................................................................................................................
M3_rs_kh7      ........................................................................................................................
M3_rs_kh8      ........................................................................................................................
M3_rs_kh9      ........................................................................................................................
M3_rs_kh10     ........................................................................................................................
M3_rs_kh11     ........................................................................................................................
M3_rs_kh12     ........................................................................................................................
M3_rs_kh13     ........................................................................................................................
M3_rs_kh14     ........................................................................................................................
M3_rs_kh15     ........................................................................................................................
M3_rs_kh16     ........................................................................................................................
M3_rs_kh17     ........................................................................................................................
M3_rs_kh18     ........................................................................................................................
M3_rs_kh19     ........................................................................................................................
M3_rs_kh20     ........................................................................................................................
M3_rs_kh21     ........................................................................................................................
M3_rs_kh22     ........................................................................................................................
M3_rs_kh23     ........................................................................................................................
M3_rs_kh24     ........................................................................................................................
M3_rs_kh25     ........................................................................................................................
M3_rs_kh26     ........................................................................................................................
M3_rs_kh27     ........................................................................................................................
M3_rs_kh28     ........................................................................................................................
M3_rs_kh29     ........................................................................................................................
M3_rs_kh30     ........................................................................................................................
M3_rs_kh31     ........................................................................................................................
M4_rs_kh32     ........................................................................................................................
M5_rs_ot1      ........................................................................................................................
M6_rs_ri1      ........................................................................................................................
M6_rs_ri2      ........................................................................................................................
M7_cn_hj1      ........................................................................................................................
M8_cn_hj2      ........................................................................................................................
M8_cn_hj3      ........................................................................................................................
M8_cn_hj4      ........................................................................................................................
M9_cn_hj5      ........................................................................................................................
M10_cn_nm1     ........................................................................................................................
M11_cn_ul1     ........................................................................................................................
M12_cn_sb1     ........................................................................................................................
M12_cn_sb2     ........................................................................................................................
M13_kr_od1     ........................................................................................................................
M14_kr_jm1     ........................................................................................................................
M14_kr_jm2     ........................................................................................................................
M14_kr_jm3     ........................................................................................................................
M15_kr_dg1     ........................................................................................................................
M16_kr_dr1     ........................................................................................................................
M17_kr_sw1     ........................................................................................................................
M17_kr_sw2     ........................................................................................................................
M18_kr_hg1     ........................................................................................................................
M19_kr_gy1     ........................................................................................................................
M20_kr_nh1     ........................................................................................................................
M20_kr_nh2     ........................................................................................................................
M21_kr_gu1     ........................................................................................................................
M22_kr_mp1     ........................................................................................................................
M23_kr_bc1     ........................................................................................................................
M24_kr_os1     ........................................................................................................................
M25_kr_os2     ........................................................................................................................
M25_kr_os3     ........................................................................................................................
M25_kr_os4     ........................................................................................................................
M25_kr_os5     ........................................................................................................................
M26_kr_sn1     ........................................................................................................................
M27_kr_gn1     ........................................................................................................................
M27_kr_gn2     ........................................................................................................................
M28_kr_bs1     ........................................................................................................................
M28_kr_bs2     ........................................................................................................................
M28_kr_bs3     ........................................................................................................................
M29_kr_jn1     ........................................................................................................................
M30_kr_bl1     ........................................................................................................................
M30_kr_bl2     ........................................................................................................................
M31_kr_jl1     ..............................................................................................................A.........
M31_kr_jl2     ........................................................................................................................
M32_kr_mt1     ........................................................................................................................
M33_kr_md1     ........................................................................................................................
M33_kr_md2     ........................................................................................................................
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Appendix 2. (Continued).

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                                                                                                                                     960
A1_kr_gr1      CAAAGTACAGTTTACTAGTTGTAAGACGTTTAGTTATTCGAATGTATCAACAGAATCATTCGATTCTTTCTGTTAATGATTCTAATAAAAATAAATTTATTGTACTCCCCCAAAATTTGT
M34_kr_dn1     ........................................................................................................................
M34_kr_dn2     ........................................................................................................................
M35_kr_sm1     ........................................................................................................................
M35_kr_sm2     ........................................................................................................................
P1_rs_ms1      ........................................................................................................................
P1_rs_ms2      ........................................................................................................................
P1_rs_ms3      ........................................................................................................................
P1_rs_ms4      ........................................................................................................................
P2_rs_nk1      ........................................................................................................................
P2_rs_nk2      ........................................................................................................................
P3_rs_pr1      ........................................................................................................................
P4_rs_pr2      ........................................................................................................................
P4_rs_pr3      ........................................................................................................................
P5_rs_rc1      ........................................................................................................................
P5_rs_rc2      ........................................................................................................................
P5_rs_rc3      ........................................................................................................................
P6_rs_rc4      ........................................................................................................................
P6_rs_rc5      ........................................................................................................................
P6_rs_rc6      ........................................................................................................................
P6_rs_rc7      ........................................................................................................................
P6_rs_rc8      ........................................................................................................................
P7_rs_us1      ........................................................................................................................
P7_rs_us2      ........................................................................................................................
P8_rs_pr4      ........................................................................................................................
P9_rs_pr5      ........................................................................................................................
P10_cn_jl1     ........................................................................................................................
P10_cn_jl2     ........................................................................................................................
P11_cn_jl3     ........................................................................................................................
P11_cn_jl4     ........................................................................................................................
P12_cn_sn1     ........................................................................................................................
P12_cn_sn2     ........................................................................................................................
P13_cn_mc1     ........................................................................................................................
P13_cn_mc2     ........................................................................................................................
P14_kr_hw1     ........................................................................................................................
P14_kr_hw2     ........................................................................................................................
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P15_kr_dm3     ........................................................................................................................
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P16_kr_sk8     ........................................................................................................................
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P19_kr_gw1     ........................................................................................................................
P19_kr_gw2     ........................................................................................................................
P19_kr_gw3     ........................................................................................................................
P20_kr_ck1     ........................................................................................................................
P20_kr_ck2     ........................................................................................................................
P21_kr_hc1     ........................................................................................................................
P22_kr_hb1     ........................................................................................................................
P23_kr_hb2     ........................................................................................................................
P24_kr_mh1     ........................................................................................................................
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P27_kr_so5     ........................................................................................................................
P27_kr_so6     ........................................................................................................................
P28_kr_il1     ........................................................................................................................
P29_kr_mj1     ........................................................................................................................
P29_kr_mj2     ........................................................................................................................
P30_kr_dk1     ........................................................................................................................
P31_kr_jr1     ........................................................................................................................
P32_kr_jr2     ........................................................................................................................
O1_jp_rb1      ........................................................................................................................
O2_jp_hk1      ........................................................................................................................
O2_jp_hk2      ........................................................................................................................
O2_jp_hk3      ........................................................................................................................
O2_jp_hk4      ........................................................................................................................
J1_jp_hn1      ........................................................................................................................
J1_jp_hn2      ........................................................................................................................
J2_jp_ky1      ........................................................................................................................
J3_jp_jp1      ........................................................................................................................
B1_cn_bj1      ........................................................................................................................
B2_uk_1        ........................................................................................................................
AMP_cn_1       ........................A...................................................................C.....C.....................
SUF_kr_hl1     ........................A.........................................................................C...G.................
SUF_kr_hl2     ........................A.........................................................................C...G.................
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Appendix 2. (Continued).

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                                                                                                                                                     1080
A1_kr_gr1       ATTCTCAATGGATCTCGGAGGGATTTGCAGCTATTGCGGAAATTCCATTTTCTATGCGATTAATATCTTCCCTAGAAGGAAAAGAAGTAAAAAAATACCACAATTTACGATCAATTCATT
A1_kr_gr2       ........................................................................................................................
A2_kr_hl1       ........................................................................................................................
A2_kr_hl2       ........................................................................................................................
A2_kr_hl3       ........................................................................................................................
A2_kr_hl4       ........................................................................................................................
A3_kr_hl5       ........................................................................................................................
A3_kr_hl6       ........................................................................................................................
A3_kr_hl7       ........................................................................................................................
A3_kr_hl8       ........................................................................................................................
A4_kr_hl9       ........................................................................................................................
A5_kr_hl10      ........................................................................................................................
A5_kr_hl11      ........................................................................................................................
A5_kr_hl12      ........................................................................................................................
A5_kr_hl13      ........................................................................................................................
A5_kr_hl14      ........................................................................................................................
A7_mn_1         ........................................................................................................................
A8_mn_2         ........................................................................................................................
M1_rs_kb1       ........................................................................................................................
M2_rs_kh1       ........................................................................................................................
M2_rs_kh2       ........................................................................................................................
M2_rs_kh3       ........................................................................................................................
M3_rs_kh4       ........................................................................................................................
M3_rs_kh5       ........................................................................................................................
M3_rs_kh6       ........................................................................................C...............................
M3_rs_kh7       ........................................................................................C...............................
M3_rs_kh8       ........................................................................................................................
M3_rs_kh9       ........................................................................................C...............................
M3_rs_kh10      ........................................................................................C...............................
M3_rs_kh11      ........................................................................................C...............................
M3_rs_kh12      ........................................................................................C...............................
M3_rs_kh13      ........................................................................................C...............................
M3_rs_kh14      ........................................................................................C...............................
M3_rs_kh15      ........................................................................................................................
M3_rs_kh16      ........................................................................................................................
M3_rs_kh17      ........................................................................................................................
M3_rs_kh18      ........................................................................................C...............................
M3_rs_kh19      ........................................................................................................................
M3_rs_kh20      ........................................................................................C...............................
M3_rs_kh21      ........................................................................................................................
M3_rs_kh22      ........................................................................................................................
M3_rs_kh23      ........................................................................................C...............................
M3_rs_kh24      ........................................................................................................................
M3_rs_kh25      ........................................................................................................................
M3_rs_kh26      ........................................................................................C...............................
M3_rs_kh27      ........................................................................................................................
M3_rs_kh28      ........................................................................................................................
M3_rs_kh29      ........................................................................................................................
M3_rs_kh30      ........................................................................................C...............................
M3_rs_kh31      ........................................................................................................................
M4_rs_kh32      ........................................................................................................................
M5_rs_ot1       ........................................................................................C...............................
M6_rs_ri1       .........................C..............................................................C...............................
M6_rs_ri2       ........................................................................................................................
M7_cn_hj1       .......................................................................................G................................
M8_cn_hj3       ........................................................................................................................
M8_cn_hj2       ........................................................................................................................
M8_cn_hj4       ........................................................................................................................
M9_cn_hj5       ........................................................................................................................
M10_cn_nm1      ........................................................................................................................
M11_cn_ul1      ........................................................................................................................
M12_cn_sb1      ........................................................................................................................
M12_cn_sb2      ........................................................................................................................
M13_kr_od1      ........................................................................................................................
M14_kr_jm1      ........................................................................................C...............................
M14_kr_jm2      ........................................................................................C...............................
M14_kr_jm3      ........................................................................................C...............................
M15_kr_dg1      .......................................................................................G................................
M16_kr_dr1      ........................................................................................................................
M17_kr_sw1      ........................................................................................................................
M17_kr_sw2      ........................................................................................................................
M18_kr_hg1      ........................................................................................................................
M19_kr_gy1      ........................................................................................................................
M20_kr_nh1      ........................................................................................C...............................
M20_kr_nh2      ........................................................................................C...............................
M21_kr_gu1      ........................................................................................................................
M22_kr_mp1      ........................................................................................................................
M23_kr_bc1      ........................................................................................................................
M24_kr_os1      ........................................................................................................................
M25_kr_os2      ........................................................................................................................
M25_kr_os3      ........................................................................................C...............................
M25_kr_os4      ........................................................................................................................
M25_kr_os5      ........................................................................................................................
M26_kr_sn1      ........................................................................................................................
M27_kr_gn1      ........................................................................................................................
M27_kr_gn2      ........................................................................................................................
M28_kr_bs1      ........................................................................................C...............................
M28_kr_bs2      ........................................................................................................................
M28_kr_bs3      ........................................................................................C...............................
M29_kr_jn1      ........................................................................................................................
M30_kr_bl1      ........................................................................................................................
M30_kr_bl2      ........................................................................................C...............................
M31_kr_jl1      ........................................................................................C...............................
M31_kr_jl2      ........................................................................................................................
M32_kr_mt1      ........................................................................................................................
M33_kr_md1      ........................................................................................................................
M33_kr_md2      ........................................................................................................................
```

Appendix 2. (Continued).

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                                                                                                                                  1080
A1_kr_gr1      ATTCTCAATGGATCTCGGAGGGATTTGCAGCTATTGCGGAAATTCCATTTTCTATGCGATTAATATCTTCCCTAGAAGGAAAAGAAGTAAAAAAATACCACAATTTACGATCAATTCATT
M34_kr_dn1     ........................................................................................................................
M34_kr_dn2     ........................................................................................................................
M35_kr_sm1     ........................................................................................................................
M35_kr_sm2     ........................................................................................................................
P1_rs_ms1      ........................................................................................................................
P1_rs_ms2      ........................................................................................................................
P1_rs_ms3      .........................................................A..............................................................
P1_rs_ms4      ........................................................................................................................
P2_rs_nk1      ........................................................................................................................
P2_rs_nk2      ........................................................................................................................
P3_rs_pr1      ........................................................................................................................
P4_rs_pr2      ........................................................................................................................
P4_rs_pr3      .........................C..............................................................C...............................
P5_rs_rc1      ........................................................................................C...............................
P5_rs_rc2      ........................................................................................................................
P5_rs_rc3      ........................................................................................................................
P6_rs_rc4      ........................................................................................C...............................
P6_rs_rc5      ........................................................................................C...............................
P6_rs_rc6      ........................................................................................C...............................
P6_rs_rc7      ........................................................................................C...............................
P6_rs_rc8      ........................................................................................................................
P7_rs_us1      ........................................................................................................................
P7_rs_us2      ........................................................................................................................
P8_rs_pr4      ........................................................................................................................
P9_rs_pr5      ........................................................................................C...............................
P10_cn_jl1     ........................................................................................................................
P10_cn_jl2     ........................................................................................................................
P11_cn_jl3     ........................................................................................................................
P11_cn_jl4     ........................................................................................................................
P12_cn_sn1     ........................................................................................................................
P12_cn_sn2     ........................................................................................................................
P13_cn_mc1     ........................................................................................................................
P13_cn_mc2     ........................................................................................................................
P14_kr_hw1     ........................................................................................................................
P14_kr_hw2     ........................................................................................................................
P15_kr_dm1     ........................................................................................................................
P15_kr_dm2     ........................................................................................................................
P15_kr_dm3     ........................................................................................................................
P16_kr_sk1     ........................................................................................................................
P16_kr_sk2     ........................................................................................................................
P16_kr_sk3     ........................................................................................................................
P16_kr_sk4     ........................................................................................................................
P16_kr_sk5     ........................................................................................................................
P16_kr_sk6     ........................................................................................................................
P16_kr_sk7     ........................................................................................................................
P16_kr_sk8     ........................................................................................................................
P17_kr_sh1     ........................................................................................................................
P18_kr_gb1     ........................................................................................................................
P19_kr_gw1     ........................................................................................................................
P19_kr_gw2     ........................................................................................................................
P19_kr_gw3     ........................................................................................................................
P20_kr_ck1     ........................................................................................................................
P20_kr_ck2     ........................................................................................................................
P21_kr_hc1     ........................................................................................................................
P22_kr_hb1     ........................................................................................................................
P23_kr_hb2     ........................................................................................................................
P24_kr_mh1     ........................................................................................................................
P24_kr_mh2     ........................................................................................................................
p25_kr_tb1     ........................................................................................................................
p25_kr_tb2     ........................................................................................................................
P26_kr_tb3     ........................................................................................................................
P27_kr_so1     ........................................................................................................................
P27_kr_so2     ........................................................................................................................
P27_kr_so3     ........................................................................................................................
P27_kr_so4     ........................................................................................................................
P27_kr_so5     ........................................................................................................................
P27_kr_so6     ........................................................................................................................
P28_kr_il1     ........................................................................................................................
P29_kr_mj1     ........................................................................................................................
P29_kr_mj2     ........................................................................................................................
P30_kr_dk1     ........................................................................................................................
P31_kr_jr1     ........................................................................................................................
P32_kr_jr2     ........................................................................................................................
O1_jp_rb1      ........................................................................................................................
O2_jp_hk1      ........................................................................................................................
O2_jp_hk2      ........................................................................................................................
O2_jp_hk3      ........................................................................................................................
O2_jp_hk4      ........................................................................................................................
J1_jp_hn1      ........................................................................................................................
J1_jp_hn2      ........................................................................................................................
J2_jp_ky1      ........................................................................................C...............................
J3_jp_jp1      ........................................................................................................................
B1_cn_bj1      ........................................................................................C...............................
B2_uk_1        ........................................................................................C...............................
AMP_cn_1       ..................G.........................................................................C...........................
SUF_kr_hl1     ........A.......A.G.....................................................................................................
SUF_kr_hl2     ........A.......A.G.....................................................................................................
```

Appendix 2. (Continued).

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                                                                                                                                  1200
A1_kr_gr1      CCATATTTCCTTTTTTAGAGGACAAATTTTCACGTTTAAATTATGTGTTAGATATATTGATACCTCACCCTATCCATTTTGAAATCTTGGTTCAAATGATTCGTTCCTGGGTAAAAGATA
A1_kr_gr2      ........................................................................................................................
A2_kr_hl1      ........................................................................................................................
A2_kr_hl2      ........................................................................................................................
A2_kr_hl3      ........................................................................................................................
A2_kr_hl4      ........................................................................................................................
A3_kr_hl5      ........................................................................................................................
A3_kr_hl6      ........................................................................................................................
A3_kr_hl7      ........................................................................................................................
A3_kr_hl8      ........................................................................................................................
A4_kr_hl9      ........................................................................................................................
A5_kr_hl10     ........................................................................................................................
A5_kr_hl11     ........................................................................................................................
A5_kr_hl12     ........................................................................................................................
A5_kr_hl13     ........................................................................................................................
A5_kr_hl14     ........................................................................................................................
A7_mn_1        ........................................................................................................................
A8_mn_2        ........................................................................................................................
M1_rs_kb1      ........................................................................................................................
M2_rs_kh1      ........................................................................................................................
M2_rs_kh2      ........................................................................................................................
M2_rs_kh3      ........................................................................................................................
M3_rs_kh4      ........................................................................................................................
M3_rs_kh5      ........................................................................................................................
M3_rs_kh6      ........................................................................................................................
M3_rs_kh7      ........................................................................................................................
M3_rs_kh8      ........................................................................................................................
M3_rs_kh9      ........................................................................................................................
M3_rs_kh10     ........................................................................................................................
M3_rs_kh11     ........................................................................................................................
M3_rs_kh12     ........................................................................................................................
M3_rs_kh13     ........................................................................................................................
M3_rs_kh14     ........................................................................................................................
M3_rs_kh15     ........................................................................................................................
M3_rs_kh16     ........................................................................................................................
M3_rs_kh17     ........................................................................................................................
M3_rs_kh18     ........................................................................................................................
M3_rs_kh19     ........................................................................................................................
M3_rs_kh20     ........................................................................................................................
M3_rs_kh21     ........................................................................................................................
M3_rs_kh22     ........................................................................................................................
M3_rs_kh23     ........................................................................................................................
M3_rs_kh24     ........................................................................................................................
M3_rs_kh25     ........................................................................................................................
M3_rs_kh26     ........................................................................................................................
M3_rs_kh27     ........................................................................................................................
M3_rs_kh28     ........................................................................................................................
M3_rs_kh29     ........................................................................................................................
M3_rs_kh30     ........................................................................................................................
M3_rs_kh31     ........................................................................................................................
M4_rs_kh32     ........................................................................................................................
M5_rs_ot1      ........................................................................................................................
M6_rs_ri1      ....................................................G...................................................................
M6_rs_ri2      ........................................................................................................................
M7_cn_hj1      ........................................................................................................................
M8_cn_hj2      ........................................................................................................................
M8_cn_hj3      ........................................................................................................................
M8_cn_hj4      ........................................................................................................................
M9_cn_hj5      ........................................................................................................................
M10_cn_nm1     ........................................................................................................................
M11_cn_ul1     ........................................................................................................................
M12_cn_sb1     ........................................................................................................................
M12_cn_sb2     ........................................................................................................................
M13_kr_od1     ........................................................................................................................
M14_kr_jm1     ........................................................................................................................
M14_kr_jm2     ........................................................................................................................
M14_kr_jm3     ........................................................................................................................
M15_kr_dg1     ........................................................................................................................
M16_kr_dr1     ........................................................................................................................
M17_kr_sw1     ........................................................................................................................
M17_kr_sw2     ........................................................................................................................
M18_kr_hg1     ........................................................................................................................
M19_kr_gy1     ........................................................................................................................
M20_kr_nh1     ........................................................................................................................
M20_kr_nh2     ........................................................................................................................
M21_kr_gu1     ........................................................................................................................
M22_kr_mp1     ........................................................................................................................
M23_kr_bc1     ........................................................................................................................
M24_kr_os1     ........................................................................................................................
M25_kr_os2     ........................................................................................................................
M25_kr_os3     ....................................................G...................................................................
M25_kr_os4     ........................................................................................................................
M25_kr_os5     ........................................................................................................................
M26_kr_sn1     ........................................................................................................................
M27_kr_gn1     ........................................................................................................................
M27_kr_gn2     ........................................................................................................................
M28_kr_bs1     ........................................................................................................................
M28_kr_bs2     ........................................................................................................................
M28_kr_bs3     ........................................................................................................................
M29_kr_jn1     ........................................................................................................................
M30_kr_bl1     ........................................................................................................................
M30_kr_bl2     ........................................................................................................................
M31_kr_jl1     ........................................................................................................................
M31_kr_jl2     ........................................................................................................................
M32_kr_mt1     ........................................................................................................................
M33_kr_md1     ........................................................................................................................
M33_kr_md2     ........................................................................................................................
```

Appendix 2. (Continued).

```
                                                                                                                                      1200
A1_kr_gr1      CCATATTTCCTTTTTTAGAGGACAAATTTTCACGTTTAAATTATGTGTTAGATATATTGATACCTCACCCTATCCATTTTGAAATCTTGGTTCAAATGATTCGTTCCTGGGTAAAAGATA
M34_kr_dn1     ........................................................................................................................
M34_kr_dn2     ........................................................................................................................
M35_kr_sm1     ........................................................................................................................
M35_kr_sm2     ........................................................................................................................
P1_rs_ms1      ........................................................................................................................
P1_rs_ms2      ........................................................................................................................
P1_rs_ms3      ........................................................................................................................
P1_rs_ms4      ........................................................................................................................
P2_rs_nk1      ........................................................................................................................
P2_rs_nk2      ........................................................................................................................
P3_rs_pr1      ........................................................................................................................
P4_rs_pr2      ........................................................................................................................
P4_rs_pr3      ....................................................G...................................................................
P5_rs_rc1      ........................................................................................................................
P5_rs_rc2      ........................................................................................................................
P5_rs_rc3      ........................................................................................................................
P6_rs_rc4      ........................................................................................................................
P6_rs_rc5      ........................................................................................................................
P6_rs_rc6      ........................................................................................................................
P6_rs_rc7      ........................................................................................................................
P6_rs_rc8      ........................................................................................................................
P7_rs_us1      ........................................................................................................................
P7_rs_us2      ........................................................................................................................
P8_rs_pr4      ........................................................................................................................
P9_rs_pr5      ........................................................................................................................
P10_cn_jl1     ........................................................................................................................
P10_cn_jl2     ........................................................................................................................
P11_cn_jl3     ........................................................................................................................
P11_cn_jl4     ........................................................................................................................
P12_cn_sn1     ........................................................................................................................
P12_cn_sn2     ........................................................................................................................
P13_cn_mc1     ........................................................................................................................
P13_cn_mc2     ........................................................................................................................
P14_kr_hw1     ........................................................................................................................
P14_kr_hw2     ........................................................................................................................
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P15_kr_dm3     ........................................................................................................................
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P16_kr_sk7     ........................................................................................................................
P16_kr_sk8     ........................................................................................................................
P17_kr_sh1     ........................................................................................................................
P18_kr_gb1     ........................................................................................................................
P19_kr_gw1     ........................................................................................................................
P19_kr_gw2     ........................................................................................................................
P19_kr_gw3     ........................................................................................................................
P20_kr_ck1     ........................................................................................................................
P20_kr_ck2     ........................................................................................................................
P21_kr_hc1     ........................................................................................................................
P22_kr_hb1     ........................................................................................................................
P23_kr_hb2     ........................................................................................................................
P24_kr_mh1     ........................................................................................................................
P24_kr_mh2     ........................................................................................................................
p25_kr_tb1     ........................................................................................................................
p25_kr_tb2     ........................................................................................................................
P26_kr_tb3     ........................................................................................................................
P27_kr_so1     ........................................................................................................................
P27_kr_so2     .........................................................................................................................
P27_kr_so3     ........................................................................................................................
P27_kr_so4     ........................................................................................................................
P27_kr_so5     ........................................................................................................................
P27_kr_so6     ........................................................................................................................
P28_kr_il1     ........................................................................................................................
P29_kr_mj1     ........................................................................................................................
P29_kr_mj2     ........................................................................................................................
P30_kr_dk1     ........................................................................................................................
P31_kr_jr1     ........................................................................................................................
P32_kr_jr2     ........................................................................................................................
O1_jp_rb1      ........................................................................................................................
O2_jp_hk1      ........................................................................................................................
O2_jp_hk2      ........................................................................................................................
O2_jp_hk3      ........................................................................................................................
O2_jp_hk4      ........................................................................................................................
J1_jp_hn1      ........................................................................................................................
J1_jp_hn2      ........................................................................................................................
J2_jp_ky1      ........................................................................................................................
J3_jp_jp1      ........................................................................................................................
B1_cn_bj1      ........................................................................................................................
B2_uk_1        .....................................C..................................................................................
AMP_cn_1       ........................................................................................................................
SUF_kr_hl1     ........................................................................................................................
SUF_kr_hl2     ........................................................................................................................
```

Appendix 2. (Continued).

```
                                                                                                                                   1320
A1_kr_gr1      TTTCCTGTTTGCATTTATTGCGATTCTTTCTTTATGAGTATTGTAATAGAGTTATTACTCTAAAAAGGTCTGTTTCAAAAAACAAGAATCAAAGATTCTTATTGTTCCTATATAATTCCT
A1_kr_gr2      ........................................................................................................................
A2_kr_hl1      ........................................................................................................................
A2_kr_hl2      ........................................................................................................................
A2_kr_hl3      ........................................................................................................................
A2_kr_hl4      ........................................................................................................................
A3_kr_hl5      ........................................................................................................................
A3_kr_hl6      ........................................................................................................................
A3_kr_hl7      ........................................................................................................................
A3_kr_hl8      ........................................................................................................................
A4_kr_hl9      ........................................................................................................................
A5_kr_hl10     ........................................................................................................................
A5_kr_hl11     ........................................................................................................................
A5_kr_hl12     ........................................................................................................................
A5_kr_hl13     ........................................................................................................................
A5_kr_hl14     ................C.......................................................................................................
A7_mn_1        ........................................................................................................................
A8_mn_2        ........................................................................................................................
M1_rs_kb1      ........................................................................................................................
M2_rs_kh1      ........................................................................................................................
M2_rs_kh2      ........................................................................................................................
M2_rs_kh3      ........................................................................................................................
M3_rs_kh4      ........................................................................................................................
M3_rs_kh5      ........................................................................................................................
M3_rs_kh6      ........................................................................................................................
M3_rs_kh7      ........................................................................................................................
M3_rs_kh8      ........................................................................................................................
M3_rs_kh9      ........................................................................................................................
M3_rs_kh10     ........................................................................................................................
M3_rs_kh11     ........................................................................................................................
M3_rs_kh12     ........................................................................................................................
M3_rs_kh13     ........................................................................................................................
M3_rs_kh14     ........................................................................................................................
M3_rs_kh15     ........................................................................................................................
M3_rs_kh16     ........................................................................................................................
M3_rs_kh17     ........................................................................................................................
M3_rs_kh18     ........................................................................................................................
M3_rs_kh19     ........................................................................................................................
M3_rs_kh20     ........................................................................................................................
M3_rs_kh21     ........................................................................................................................
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M3_rs_kh23     ........................................................................................................................
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M3_rs_kh25     ........................................................................................................................
M3_rs_kh26     ........................................................................................................................
M3_rs_kh27     ........................................................................................................................
M3_rs_kh28     ........................................................................................................................
M3_rs_kh29     ........................................................................................................................
M3_rs_kh30     ........................................................................................................................
M3_rs_kh31     ........................................................................................................................
M4_rs_kh32     ........................................................................................................................
M5_rs_ot1      ........................................................................................................................
M6_rs_ri1      ........................................................................................................................
M6_rs_ri2      ................C.......................................................................................................
M7_cn_hj1      ........................................................................................................................
M8_cn_hj2      ................C.......................................................................................................
M8_cn_hj3      ........................................................................................................................
M8_cn_hj4      ........................................................................................................................
M9_cn_hj5      ........................................................................................................................
M10_cn_nm1     ........................................................................................................................
M11_cn_ul1     ........................................................................................................................
M12_cn_sb1     ........................................................................................................................
M12_cn_sb2     ........................................................................................................................
M13_kr_od1     ........................................................................................................................
M14_kr_jm1     ........................................................................................................................
M14_kr_jm2     ........................................................................................................................
M14_kr_jm3     ........................................................................................................................
M15_kr_dg1     ........................................................................................................................
M16_kr_dr1     ........................................................................................................................
M17_kr_sw1     .....................A..................................................................................................
M17_kr_sw2     .....................A..................................................................................................
M18_kr_hg1     ........................................................................................................................
M19_kr_gy1     ........................................................................................................................
M20_kr_nh1     ........................................................................................................................
M20_kr_nh2     ........................................................................................................................
M21_kr_gu1     ........................................................................................................................
M22_kr_mp1     ........................................................................................................................
M23_kr_bc1     ........................................................................................................................
M24_kr_os1     ........................................................................................................................
M25_kr_os2     ........................................................................................................................
M25_kr_os3     ........................................................................................................................
M25_kr_os4     ........................................................................................................................
M25_kr_os5     ........................................................................................................................
M26_kr_sn1     ........................................................................................................................
M27_kr_gn1     ................C.......................................................................................................
M27_kr_gn2     ................C.......................................................................................................
M28_kr_bs1     ........................................................................................................................
M28_kr_bs2     ........................................................................................................................
M28_kr_bs3     ........................................................................................................................
M29_kr_jn1     ........................................................................................................................
M30_kr_bl1     ........................................................................................................................
M30_kr_bl2     ........................................................................................................................
M31_kr_jl1     ........................................................................................................................
M31_kr_jl2     ........................................................................................................................
M32_kr_mt1     ........................................................................................................................
M33_kr_md1     ........................................................................................................................
M33_kr_md2     ........................................................................................................................
```

Appendix 2. (Continued).

```
                                                                                                                                   1320
A1_kr_gr1      TTTCCTGTTTGCATTTATTGCGATTCTTTCTTTATGAGTATTGTAATAGAGTTATTACTCTAAAAAGGTCTGTTTCAAAAAACAAGAATCAAAGATTCTTATTGTTCCTATATAATTCCT
M34_kr_dn1     ........................................................................................................................
M34_kr_dn2     ........................................................................................................................
M35_kr_sm1     ........................................................................................................................
M35_kr_sm2     ........................................................................................................................
P1_rs_ms1      ........................................................................................................................
P1_rs_ms2      ........................................................................................................................
P1_rs_ms3      ........................................................................................................................
P1_rs_ms4      ........................................................................................................................
P2_rs_nk1      ........................................................................................................................
P2_rs_nk2      ........................................................................................................................
P3_rs_pr1      ................C.......................................................................................................
P4_rs_pr2      ................C.......................................................................................................
P4_rs_pr3      ........................................................................................................................
P5_rs_rc1      ........................................................................................................................
P5_rs_rc2      ........................................................................................................................
P5_rs_rc3      ........................................................................................................................
P6_rs_rc4      ........................................................................................................................
P6_rs_rc5      ........................................................................................................................
P6_rs_rc6      ........................................................................................................................
P6_rs_rc7      ........................................................................................................................
P6_rs_rc8      ........................................................................................................................
P7_rs_us1      ........................................................................................................................
P7_rs_us2      ........................................................................................................................
P8_rs_pr4      ................C.......................................................................................................
P9_rs_pr5      ........................................................................................................................
P10_cn_jl1     ........................................................................................................................
P10_cn_jl2     ........................................................................................................................
P11_cn_jl3     ........................................................................................................................
P11_cn_jl4     ........................................................................................................................
P12_cn_sn1     ........................................................................................................................
P12_cn_sn2     ........................................................................................................................
P13_cn_mc1     ........................................................................................................................
P13_cn_mc2     ........................................................................................................................
P14_kr_hw1     ........................................................................................................................
P14_kr_hw2     ........................................................................................................................
P15_kr_dm1     ........................................................................................................................
P15_kr_dm2     ........................................................................................................................
P15_kr_dm3     ........................................................................................................................
P16_kr_sk1     ........................................................................................................................
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P16_kr_sk4     ........................................................................................................................
P16_kr_sk5     ........................................................................................................................
P16_kr_sk6     ........................................................................................................................
P16_kr_sk7     ........................................................................................................................
P16_kr_sk8     ........................................................................................................................
P17_kr_sh1     ........................................................................................................................
P18_kr_gb1     ........................................................................................................................
P19_kr_gw1     ........................................................................................................................
P19_kr_gw2     ........................................................................................................................
P19_kr_gw3     ................C.......................................................................................................
P20_kr_ck1     ........................................................................................................................
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P21_kr_hc1     ........................................................................................................................
P22_kr_hb1     ........................................................................................................................
P23_kr_hb2     ........................................................................................................................
P24_kr_mh1     ........................................................................................................................
P24_kr_mh2     ........................................................................................................................
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P27_kr_so2     ........................................................................................................................
P27_kr_so3     ........................................................................................................................
P27_kr_so4     ........................................................................................................................
P27_kr_so5     ........................................................................................................................
P27_kr_so6     ........................................................................................................................
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P29_kr_mj1     ........................................................................................................................
P29_kr_mj2     ........................................................................................................................
P30_kr_dk1     ........................................................................................................................
P31_kr_jr1     ........................................................................................................................
P32_kr_jr2     ........................................................................................................................
O1_jp_rb1      ........................................................................................................................
O2_jp_hk1      ........................................................................................................................
O2_jp_hk2      ........................................................................................................................
O2_jp_hk3      ........................................................................................................................
O2_jp_hk4      ........................................................................................................................
J1_jp_hn1      ........................................................................................................................
J1_jp_hn2      ........................................................................................................................
J2_jp_ky1      ........................................................................................................................
J3_jp_jp1      ........................................................................................................................
B1_cn_bj1      .........................................................................................A..............................
B2_uk_1        ........................................................................................................................
AMP_cn_1       ..................................................................................T.....................................
SUF_kr_hl1     ........................................................................................................................
SUF_kr_hl2     ........................................................................................................................
```

Appendix 2. (Continued).

```
                                                                                                                                   1440
A1_kr_gr1      ATGTGTGTGAATGCGAATCCATCTTCGTTTTTATCCGCAACCAATCCTCTAATTTACGATCACCATCTTACGGAGCCTTTCTTGCACGAATCTATTTCTACCTAAAGTTAGAACAGTTTT
A1_kr_gr2      ........................................................................................................................
A2_kr_hl1      ........................................................................................................................
A2_kr_hl2      ........................................................................................................................
A2_kr_hl3      ........................................................................................................................
A2_kr_hl4      .....................G..................................................................................................
A3_kr_hl5      ........................................................................................................................
A3_kr_hl6      ........................................................................................................................
A3_kr_hl7      .....................G..................................................................................................
A3_kr_hl8      .....................G..................................................................................................
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A5_kr_hl11     ........................................................................................................................
A5_kr_hl12     ........................................................................................................................
A5_kr_hl13     ........................................................................................................................
A5_kr_hl14     ........................................................................................................................
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A8_mn_2        ........................................................................................................................
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M2_rs_kh1      ........................................................................................................................
M2_rs_kh2      ........................................................................................................................
M2_rs_kh3      ........................................................................................................................
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M3_rs_kh5      ........................................................................................................................
M3_rs_kh6      ......................................................................................................G.................
M3_rs_kh7      ......................................................................................................G.................
M3_rs_kh8      ........................................................................................................................
M3_rs_kh9      ......................................................................................................G.................
M3_rs_kh10     ......................................................................................................G.................
M3_rs_kh11     ......................................................................................................G.................
M3_rs_kh12     ......................................................................................................G.................
M3_rs_kh13     ......................................................................................................G.................
M3_rs_kh14     ......................................................................................................G.................
M3_rs_kh15     ........................................................................................................................
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M3_rs_kh21     ........................................................................................................................
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M3_rs_kh26     ......................................................................................................G.................
M3_rs_kh27     ........................................................................................................................
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M3_rs_kh29     ........................................................................................................................
M3_rs_kh30     ......................................................................................................G.................
M3_rs_kh31     ........................................................................................................................
M4_rs_kh32     ........................................................................................................................
M5_rs_ot1      ........................................................................................................................
M6_rs_ri1      ........................................................................................................................
M6_rs_ri2      ........................................................................................................................
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M8_cn_hj2      ........................................................................................................................
M8_cn_hj3      ........................................................................................................................
M8_cn_hj4      ........................................................................................................................
M9_cn_hj5      ........................................................................................................................
M10_cn_nm1     ........................................................................................................................
M11_cn_ul1     ........................................................................................................................
M12_cn_sb1     ........................................................................................................................
M12_cn_sb2     ........................................................................................................................
M13_kr_od1     ........................................................................................................................
M14_kr_jm1     ......................................................................................................G.................
M14_kr_jm2     ......................................................................................................G.................
M14_kr_jm3     ......................................................................................................G.................
M15_kr_dg1     ........................................................................................................................
M16_kr_dr1     ........................................................................................................................
M17_kr_sw1     ........................................................................................................................
M17_kr_sw2     ........................................................................................................................
M18_kr_hg1     ........................................................................................................................
M19_kr_gy1     ........................................................................................................................
M20_kr_nh1     ........................................................................................................................
M20_kr_nh2     ........................................................................................................................
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M22_kr_mp1     ........................................................................................................................
M23_kr_bc1     ........................................................................................................................
M24_kr_os1     ........................................................................................................................
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M25_kr_os4     ........................................................................................................................
M25_kr_os5     ........................................................................................................................
M26_kr_sn1     ........................................................................................................................
M27_kr_gn1     ........................................................................................................................
M27_kr_gn2     ........................................................................................................................
M28_kr_bs1     ..................................................C.....................................................................
M28_kr_bs2     ........................................................................................................................
M28_kr_bs3     ..................................................C.....................................................................
M29_kr_jn1     ........................................................................................................................
M30_kr_bl1     ........................................................................................................................
M30_kr_bl2     ........................................................................................................................
M31_kr_jl1     ........................................................................................................................
M31_kr_jl2     ........................................................................................................................
M32_kr_mt1     ........................................................................................................................
M33_kr_md1     ........................................................................................................................
M33_kr_md2     ........................................................................................................................
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Appendix 2. (Continued).

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                                                                                                                                       1440
A1_kr_gr1      ATGTGTGTGAATGCGAATCCATCTTCGTTTTTATCCGCAACCAATCCTCTAATTTACGATCACCATCTTACGGAGCCTTTCTTGCACGAATCTATTTCTACCTAAAGTTAGAACAGTTTT
M34_kr_dn1     ........................................................................................................................
M34_kr_dn2     ........................................................................................................................
M35_kr_sm1     ........................................................................................................................
M35_kr_sm2     ........................................................................................................................
P1_rs_ms1      ........................................................................................................................
P1_rs_ms2      ........................................................................................................................
P1_rs_ms3      ........................................................................................................................
P1_rs_ms4      ........................................................................................................................
P2_rs_nk1      ........................................................................................................................
P2_rs_nk2      ........................................................................................................................
P3_rs_pr1      ........................................................................................................................
P4_rs_pr2      ........................................................................................................................
P4_rs_pr3      ........................................................................................................................
P5_rs_rc1      ........................................................................................................................
P5_rs_rc2      ........................................................................................................................
P5_rs_rc3      ........................................................................................................................
P6_rs_rc4      ........................................................................................................................
P6_rs_rc5      ........................................................................................................................
P6_rs_rc6      ........................................................................................................................
P6_rs_rc7      ........................................................................................................................
P6_rs_rc8      ........................................................................................................................
P7_rs_us1      ........................................................................................................................
P7_rs_us2      ........................................................................................................................
P8_rs_pr4      ........................................................................................................................
P9_rs_pr5      ........................................................................................................................
P10_cn_jl1     ........................................................................................................................
P10_cn_jl2     ........................................................................................................................
P11_cn_jl3     ........................................................................................................................
P11_cn_jl4     ........................................................................................................................
P12_cn_sn1     ........................................................................................................................
P12_cn_sn2     ........................................................................................................................
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P13_cn_mc2     ........................................................................................................................
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P16_kr_sk8     ........................................................................................................................
P17_kr_sh1     ........................................................................................................................
P18_kr_gb1     ........................................................................................................................
P19_kr_gw1     ........................................................................................................................
P19_kr_gw2     ........................................................................................................................
P19_kr_gw3     ........................................................................................................................
P20_kr_ck1     ........................................................................................................................
P20_kr_ck2     ........................................................................................................................
P21_kr_hc1     ........................................................................................................................
P22_kr_hb1     ........................................................................................................................
P23_kr_hb2     ........................................................................................................................
P24_kr_mh1     ........................................................................................................................
P24_kr_mh2     ........................................................................................................................
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P27_kr_so4     ........................................................................................................................
P27_kr_so5     ........................................................................................................................
P27_kr_so6     ........................................................................................................................
P28_kr_il1     ........................................................................................................................
P29_kr_mj1     ........................................................................................................................
P29_kr_mj2     ........................................................................................................................
P30_kr_dk1     ........................................................................................................................
P31_kr_jr1     ........................................................................................................................
P32_kr_jr2     ........................................................................................................................
O1_jp_rb1      ........................................................................................................................
O2_jp_hk1      ........................................................................................................................
O2_jp_hk2      ........................................................................................................................
O2_jp_hk3      ........................................................................................................................
O2_jp_hk4      ........................................................................................................................
J1_jp_hn1      ........................................................................................................................
J1_jp_hn2      ........................................................................................................................
J2_jp_ky1      ........................................................................................................................
J3_jp_jp1      ........................................................................................................................
B1_cn_bj1      ........................................................................................................................
B2_uk_1        ........................................................................................................................
AMP_cn_1       ........................................................................................................................
SUF_kr_hl1     ........................................................................................................................
SUF_kr_hl2     ........................................................................................................................
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Appendix 2. (Continued).

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                                                                                                                                   1560
A1_kr_gr1      TAAAATTATGTACTAAGAATTTTCCGATTATTCTATGGTTGTTTAAGGATCTTTTTCTACATTATGTTAGGTATCAAGGAAAATGGATTCTAGTTTCAAGGGGCACATTTCTTCTGCTGA
A1_kr_gr2      ........................................................................................................................
A2_kr_hl1      ........................................................................................................................
A2_kr_hl2      ........................................................................................................................
A2_kr_hl3      ........................................................................................................................
A2_kr_hl4      ........................................................................................................................
A3_kr_hl5      ........................................................................................................................
A3_kr_hl6      ........................................................................................................................
A3_kr_hl7      ........................................................................................................................
A3_kr_hl8      ........................................................................................................................
A4_kr_hl9      ........................................................................................................................
A5_kr_hl10     ........................................................................................................................
A5_kr_hl11     ........................................................................................................................
A5_kr_hl12     ........................................................................................................................
A5_kr_hl13     ........................................................................................................................
A5_kr_hl14     ........................................................................................................................
A7_mn_1        ........................................................................................................................
A8_mn_2        ........................................................................................................................
M1_rs_kb1      ........................................................................................................................
M2_rs_kh1      ........................................................................................................................
M2_rs_kh2      ........................................................................................................................
M2_rs_kh3      ........................................................................................................................
M3_rs_kh4      ........................................................................................................................
M3_rs_kh5      ........................................................................................................................
M3_rs_kh6      ........................................................................................................................
M3_rs_kh7      ........................................................................................................................
M3_rs_kh8      ........................................................................................................................
M3_rs_kh9      ........................................................................................................................
M3_rs_kh10     ........................................................................................................................
M3_rs_kh11     ........................................................................................................................
M3_rs_kh12     ........................................................................................................................
M3_rs_kh13     ........................................................................................................................
M3_rs_kh14     ........................................................................................................................
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M3_rs_kh16     ........................................................................................................................
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M3_rs_kh18     ........................................................................................................................
M3_rs_kh19     ........................................................................................................................
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M3_rs_kh26     ........................................................................................................................
M3_rs_kh27     ........................................................................................................................
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M8_cn_hj2      ........................................................................................................................
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M9_cn_hj5      ........................................................................................................................
M10_cn_nm1     ........................................................................................................................
M11_cn_ul1     ........................................................................................................................
M12_cn_sb1     ........................................................................................................................
M12_cn_sb2     ........................................................................................................................
M13_kr_od1     ........................................................................................................................
M14_kr_jm1     ........................................................................................................................
M14_kr_jm2     ........................................................................................................................
M14_kr_jm3     ........................................................................................................................
M15_kr_dg1     ........................................................................................................................
M16_kr_dr1     ........................................................................................................................
M17_kr_sw1     ........................................................................................................................
M17_kr_sw2     ........................................................................................................................
M18_kr_hg1     ........................................................................................................................
M19_kr_gy1     ........................................................................................................................
M20_kr_nh1     ........................................................................................................................
M20_kr_nh2     ........................................................................................................................
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M22_kr_mp1     ........................................................................................................................
M23_kr_bc1     ........................................................................................................................
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M25_kr_os4     ........................................................................................................................
M25_kr_os5     ........................................................................................................................
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M27_kr_gn2     ........................................................................................................................
M28_kr_bs1     ........................................................................................................................
M28_kr_bs2     ........................................................................................................................
M28_kr_bs3     ........................................................................................................................
M29_kr_jn1     ........................................................................................................................
M30_kr_bl1     ........................................................................................................................
M30_kr_bl2     ........................................................................................................................
M31_kr_jl1     ........................................................................................................................
M31_kr_jl2     ........................................................................................................................
M32_kr_mt1     ........................................................................................................................
M33_kr_md1     ........................................................................................................................
M33_kr_md2     ........................................................................................................................
```

Appendix 2. (Continued).

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                                                                                                                                  1560
A1_kr_gr1     TAAAATTATGTACTAAGAATTTTCCGATTATTCTATGGTTGTTTAAGGATCTTTTTCTACATTATGTTAGGTATCAAGGAAAATGGATTCTAGTTTCAAGGGGCACATTTCTTCTGCTGA
M34_kr_dn1    ........................................................................................................................
M34_kr_dn2    ........................................................................................................................
M35_kr_sm1    ........................................................................................................................
M35_kr_sm2    ........................................................................................................................
P1_rs_ms1     ........................................................................................................................
P1_rs_ms2     ........................................................................................................................
P1_rs_ms3     ........................................................................................................................
P1_rs_ms4     ........................................................................................................................
P2_rs_nk1     ........................................................................................................................
P2_rs_nk2     ........................................................................................................................
P3_rs_pr1     ........................................................................................................................
P4_rs_pr2     ........................................................................................................................
P4_rs_pr3     ........................................................................................................................
P5_rs_rc1     ........................................................................................................................
P5_rs_rc2     ........................................................................................................................
P5_rs_rc3     ........................................................................................................................
P6_rs_rc4     ........................................................................................................................
P6_rs_rc5     ........................................................................................................................
P6_rs_rc6     ........................................................................................................................
P6_rs_rc7     ........................................................................................................................
P6_rs_rc8     ........................................................................................................................
P7_rs_us1     ........................................................................................................................
P7_rs_us2     ........................................................................................................................
P8_rs_pr4     ........................................................................................................................
P9_rs_pr5     ........................................................................................................................
P10_cn_jl1    ........................................................................................................................
P10_cn_jl2    ........................................................................................................................
P11_cn_jl3    ........................................................................................................................
P11_cn_jl4    ........................................................................................................................
P12_cn_sn1    ........................................................................................................................
P12_cn_sn2    ........................................................................................................................
P13_cn_mc1    ........................................................................................................................
P13_cn_mc2    ........................................................................................................................
P14_kr_hw1    ........................................................................................................................
P14_kr_hw2    ........................................................................................................................
P15_kr_dm1    ........................................................................................................................
P15_kr_dm2    ........................................................................................................................
P15_kr_dm3    ........................................................................................................................
P16_kr_sk1    ........................................................................................................................
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P16_kr_sk8    ........................................................................................................................
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P18_kr_gb1    ........................................................................................................................
P19_kr_gw1    ........................................................................................................................
P19_kr_gw2    ........................................................................................................................
P19_kr_gw3    ........................................................................................................................
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P20_kr_ck2    ........................................................................................................................
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P22_kr_hb1    ........................................................................................................................
P23_kr_hb2    ........................................................................................................................
P24_kr_mh1    ........................................................................................................................
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P27_kr_so3    ........................................................................................................................
P27_kr_so4    ........................................................................................................................
P27_kr_so5    ........................................................................................................................
P27_kr_so6    ........................................................................................................................
P28_kr_il1    ........................................................................................................................
P29_kr_mj1    ..................................................................................................................C.....
P29_kr_mj2    ..................................................................................................................C.....
P30_kr_dk1    ........................................................................................................................
P31_kr_jr1    ........................................................................................................................
P32_kr_jr2    ........................................................................................................................
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O2_jp_hk1     ........................................................................................................................
O2_jp_hk2     ........................................................................................................................
O2_jp_hk3     ........................................................................................................................
O2_jp_hk4     ........................................................................................................................
J1_jp_hn1     ........................................................................................................................
J1_jp_hn2     ........................................................................................................................
J2_jp_ky1     ........................................................................................................................
J3_jp_jp1     ........................................................................................................................
B1_cn_bj1     ........................................................................................................................
B2_uk_1       ........................................................................................................................
AMP_cn_1      ...................................................C......G............................................G................
SUF_kr_hl1    ...................................................C......G.........C..................................G................
SUF_kr_hl2    ...................................................C......G.........C..................................G................
```

Appendix 2. (Continued).

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                                                                                                                                   1680
A1_kr_gr1      CTAAATTGAAATATTACCTTGTCAATTTCTGTCAATGTAATTTTTCGTTATGGTTGCAACCAAGAAGAATCTATATCAATCAATCATCAAATCAGCGCATTGACTTTATGGGTTTTCTTT
A1_kr_gr2      ........................................................................................................................
A2_kr_hl1      ........................................................................................................................
A2_kr_hl2      ........................................................................................................................
A2_kr_hl3      ........................................................................................................................
A2_kr_hl4      ........................................................................................................................
A3_kr_hl5      ........................................................................................................................
A3_kr_hl6      ........................................................................................................................
A3_kr_hl7      ........................................................................................................................
A3_kr_hl8      ........................................................................................................................
A4_kr_hl9      ........................................................................................................................
A5_kr_hl10     ........................................................................................................................
A5_kr_hl11     ........................................................................................................................
A5_kr_hl12     ........................................................................................................................
A5_kr_hl13     ........................................................................................................................
A5_kr_hl14     ........................................................................................................................
A7_mn_1        ........................................................................................................................
A8_mn_2        ........................................................................................................................
M1_rs_kb1      ........................................................................................................................
M2_rs_kh1      ........................................................................................................................
M2_rs_kh2      ........................................................................................................................
M2_rs_kh3      ........................................................................................................................
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M3_rs_kh5      ........................................................................................................................
M3_rs_kh6      ........................................................................................................................
M3_rs_kh7      ........................................................................................................................
M3_rs_kh8      ........................................................................................................................
M3_rs_kh9      ........................................................................................................................
M3_rs_kh10     ........................................................................................................................
M3_rs_kh11     ........................................................................................................................
M3_rs_kh12     ........................................................................................................................
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M3_rs_kh30     ........................................................................................................................
M3_rs_kh31     ........................................................................................................................
M4_rs_kh32     ........................................................................................................................
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M6_rs_ri1      ........................................................................................................................
M6_rs_ri2      ........................................................................................................................
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M8_cn_hj2      ........................................................................................................................
M8_cn_hj3      ........................................................................................................................
M8_cn_hj4      ........................................................................................................................
M9_cn_hj5      ........................................................................................................................
M10_cn_nm1     ........................................................................................................................
M11_cn_ul1     ........................................................................................................................
M12_cn_sb1     ........................................................................................................................
M12_cn_sb2     ........................................................................................................................
M13_kr_od1     ........................................................................................................................
M14_kr_jm1     ........................................................................................................................
M14_kr_jm2     ........................................................................................................................
M14_kr_jm3     ........................................................................................................................
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M18_kr_hg1     ........................................................................................................................
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M20_kr_nh2     ........................................................................................................................
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M25_kr_os2     ........................................................................................................................
M25_kr_os3     ........................................................................................................................
M25_kr_os4     ........................................................................................................................
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M27_kr_gn2     ........................................................................................................................
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M28_kr_bs2     ........................................................................................................................
M28_kr_bs3     ........................................................................................................................
M29_kr_jn1     ........................................................................................................................
M30_kr_bl1     ........................................................................................................................
M30_kr_bl2     ........................................................................................................................
M31_kr_jl1     ........................................................................................................................
M31_kr_jl2     ........................................................................................................................
M32_kr_mt1     ........................................................................................................................
M33_kr_md1     ........................................................................................................................
M33_kr_md2     ........................................................................................................................
```

Appendix 2. (Continued).

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                                                                                                                                   1680
A1_kr_gr1      CTAAATTGAAATATTACCTTGTCAATTTCTGTCAATGTAATTTTTCGTTATGGTTGCAACCAAGAAGAATCTATATCAATCAATCATCAAATCAGCGCATTGACTTTATGGGTTTTCTTT
M34_kr_dn1     ........................................................................................................................
M34_kr_dn2     ........................................................................................................................
M35_kr_sm1     ........................................................................................................................
M35_kr_sm2     ........................................................................................................................
P1_rs_ms1      ........................................................................................................................
P1_rs_ms2      ........................................................................................................................
P1_rs_ms3      ........................................A...............................................................................
P1_rs_ms4      ........................................................................................................................
P2_rs_nk1      ........................................................................................................................
P2_rs_nk2      ........................................................................................................................
P3_rs_pr1      ........................................................................................................................
P4_rs_pr2      ........................................................................................................................
P4_rs_pr3      ........................................................................................................................
P5_rs_rc1      ........................................................................................................................
P5_rs_rc2      ........................................................................................................................
P5_rs_rc3      ........................................................................................................................
P6_rs_rc4      ........................................................................................................................
P6_rs_rc5      ........................................................................................................................
P6_rs_rc6      ........................................................................................................................
P6_rs_rc7      ........................................................................................................................
P6_rs_rc8      ........................................................................................................................
P7_rs_us1      ........................................................................................................................
P7_rs_us2      ........................................................................................................................
P8_rs_pr4      ........................................................................................................................
P9_rs_pr5      ........................................................................................................................
P10_cn_jl1     ........................................................................................................................
P10_cn_jl2     .......................................................................................................................
P11_cn_jl3     ........................................................................................................................
P11_cn_jl4     ........................................................................................................................
P12_cn_sn1     ........................................................................................................................
P12_cn_sn2     ........................................................................................................................
P13_cn_mc1     ........................................................................................................................
P13_cn_mc2     ........................................................................................................................
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P14_kr_hw2     ........................................................................................................................
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P15_kr_dm2     ........................................................................................................................
P15_kr_dm3     ........................................................................................................................
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P16_kr_sk8     ........................................................................................................................
P17_kr_sh1     ........................................................................................................................
P18_kr_gb1     ........................................................................................................................
P19_kr_gw1     ........................................................................................................................
P19_kr_gw2     ........................................................................................................................
P19_kr_gw3     ....................................................................C...................................................
P20_kr_ck1     ........................................................................................................................
P20_kr_ck2     ........................................................................................................................
P21_kr_hc1     ........................................................................................................................
P22_kr_hb1     ........................................................................................................................
P23_kr_hb2     ........................................................................................................................
P24_kr_mh1     ........................................................................................................................
P24_kr_mh2     ........................................................................................................................
p25_kr_tb1     ........................................................................................................................
p25_kr_tb2     ........................................................................................................................
P26_kr_tb3     ........................................................................................................................
P27_kr_so1     ........................................................................................................................
P27_kr_so2     ........................................................................................................................
P27_kr_so3     ........................................................................................................................
P27_kr_so4     ........................................................................................................................
P27_kr_so5     ........................................................................................................................
P27_kr_so6     ........................................................................................................................
P28_kr_il1     ........................................................................................................................
P29_kr_mj1     ........................................................................................................................
P29_kr_mj2     ........................................................................................................................
P30_kr_dk1     ........................................................................................................................
P31_kr_jr1     ........................................................................................................................
P32_kr_jr2     ........................................................................................................................
O1_jp_rb1      ........................................................................................................................
O2_jp_hk1      ........................................................................................................................
O2_jp_hk2      ........................................................................................................................
O2_jp_hk3      ........................................................................................................................
O2_jp_hk4      ........................................................................................................................
J1_jp_hn1      ........................................................................................................................
J1_jp_hn2      ........................................................................................................................
J2_jp_ky1      ........................................................................................................................
J3_jp_jp1      ........................................................................................................................
B1_cn_bj1      ........................................................................................................................
B2_uk_1        ........................................................................................................................
AMP_cn_1       .....................................................................................C..................................
SUF_kr_hl1     ........................................................................................................................
SUF_kr_hl2     ........................................................................................................................
```

Appendix 2. (Continued).

```
                                                                                                                                   1800
A1_kr_gr1      TAAGTGGGCGGCTAAATCCGTTCGTGGTACGGAGTCAAATGTTAGAAAATTCATTCTTAATAGAGAATGGTATTAAGAAGTTTGAGACCCTAGTTCCAATTATGCCAATGGTTGGATCAT
A1_kr_gr2      ........................................................................................................................
A2_kr_hl1      ........................................................................................................................
A2_kr_hl2      ........................................................................................................................
A2_kr_hl3      ........................................................................................................................
A2_kr_hl4      ........................................................................................................................
A3_kr_hl5      ........................................................................................................................
A3_kr_hl6      ........................................................................................................................
A3_kr_hl7      ........................................................................................................................
A3_kr_hl8      ........................................................................................................................
A4_kr_hl9      ........................................................................................................................
A5_kr_hl10     ........................................................................................................................
A5_kr_hl11     ........................................................................................................................
A5_kr_hl12     ........................................................................................................................
A5_kr_hl13     ........................................................................................................................
A5_kr_hl14     ........................................................................................................................
A7_mn_1        ........................................................................................................................
A8_mn_2        ........................................................................................................................
M1_rs_kb1      ........................................................................................................................
M2_rs_kh1      ........................................................................................................................
M2_rs_kh2      ........................................................................................................................
M2_rs_kh3      ........................................................................................................................
M3_rs_kh4      ........................................................................................................................
M3_rs_kh5      ........................................................................................................................
M3_rs_kh6      ........................................................................................................................
M3_rs_kh7      ........................................................................................................................
M3_rs_kh8      ........................................................................................................................
M3_rs_kh9      ........................................................................................................................
M3_rs_kh10     ........................................................................................................................
M3_rs_kh11     ........................................................................................................................
M3_rs_kh12     ........................................................................................................................
M3_rs_kh13     ........................................................................................................................
M3_rs_kh14     ........................................................................................................................
M3_rs_kh15     ........................................................................................................................
M3_rs_kh16     ........................................................................................................................
M3_rs_kh17     ........................................................................................................................
M3_rs_kh18     ........................................................................................................................
M3_rs_kh19     ........................................................................................................................
M3_rs_kh20     ........................................................................................................................
M3_rs_kh21     ........................................................................................................................
M3_rs_kh22     ........................................................................................................................
M3_rs_kh23     ........................................................................................................................
M3_rs_kh24     ........................................................................................................................
M3_rs_kh25     ........................................................................................................................
M3_rs_kh26     ........................................................................................................................
M3_rs_kh27     ........................................................................................................................
M3_rs_kh28     ........................................................................................................................
M3_rs_kh29     ........................................................................................................................
M3_rs_kh30     ........................................................................................................................
M3_rs_kh31     ........................................................................................................................
M4_rs_kh32     ........................................................................................................................
M5_rs_ot1      ........................................................................................................................
M6_rs_ri1      ........................................................................................................................
M6_rs_ri2      ........................................................................................................................
M7_cn_hj1      ........................................................................................................................
M8_cn_hj2      ........................................................................................................................
M8_cn_hj3      ........................................................................................................................
M8_cn_hj4      ........................................................................................................................
M9_cn_hj5      ........................................................................................................................
M10_cn_nm1     ........................................................................................................................
M11_cn_ul1     ........................................................................................................................
M12_cn_sb1     ........................................................................................................................
M12_cn_sb2     ........................................................................................................................
M13_kr_od1     ........................................................................................................................
M14_kr_jm1     ........................................................................................................................
M14_kr_jm2     ........................................................................................................................
M14_kr_jm3     ........................................................................................................................
M15_kr_dg1     ........................................................................................................................
M16_kr_dr1     ........................................................................................................................
M17_kr_sw1     ........................................................................................................................
M17_kr_sw2     ........................................................................................................................
M18_kr_hg1     ........................................................................................................................
M19_kr_gy1     ........................................................................................................................
M20_kr_nh1     ........................................................................................................................
M20_kr_nh2     ........................................................................................................................
M21_kr_gu1     ........................................................................................................................
M22_kr_mp1     ........................................................................................................................
M23_kr_bc1     ........................................................................................................................
M24_kr_os1     ........................................................................................................................
M25_kr_os2     ........................................................................................................................
M25_kr_os3     ........................................................................................................................
M25_kr_os4     ........................................................................................................................
M25_kr_os5     ........................................................................................................................
M26_kr_sn1     ........................................................................................................................
M27_kr_gn1     ........................................................................................................................
M27_kr_gn2     ........................................................................................................................
M28_kr_bs1     ........................................................................................................................
M28_kr_bs2     ........................................................................................................................
M28_kr_bs3     ........................................................................................................................
M29_kr_jn1     ........................................................................................................................
M30_kr_bl1     ........................................................................................................................
M30_kr_bl2     ........................................................................................................................
M31_kr_jl1     ........................................................................................................................
M31_kr_jl2     ........................................................................................................................
M32_kr_mt1     ........................................................................................................................
M33_kr_md1     ........................................................................................................................
M33_kr_md2     ........................................................................................................................
```

Appendix 2. (Continued).

```
                                                                                                                                   1800
A1_kr_gr1      TAAGTGGGCGGCTAAATCCGTTCGTGGTACGGAGTCAAATGTTAGAAAATTCATTCTTAATAGAGAATGGTATTAAGAAGTTTGAGACCCTAGTTCCAATTATGCCAATGGTTGGATCAT
M34_kr_dn1     ........................................................................................................................
M34_kr_dn2     ........................................................................................................................
M35_kr_sm1     ........................................................................................................................
M35_kr_sm2     ........................................................................................................................
P1_rs_ms1      ........................................................................................................................
P1_rs_ms2      ........................................................................................................................
P1_rs_ms3      ........................................................................................................................
P1_rs_ms4      ........................................................................................................................
P2_rs_nk1      ........................................................................................................................
P2_rs_nk2      ........................................................................................................................
P3_rs_pr1      ........................................................................................................................
P4_rs_pr2      ........................................................................................................................
P4_rs_pr3      ........................................................................................................................
P5_rs_rc1      ........................................................................................................................
P5_rs_rc2      ........................................................................................................................
P5_rs_rc3      ........................................................................................................................
P6_rs_rc4      ........................................................................................................................
P6_rs_rc5      ........................................................................................................................
P6_rs_rc6      ........................................................................................................................
P6_rs_rc7      ........................................................................................................................
P6_rs_rc8      ........................................................................................................................
P7_rs_us1      ........................................................................................................................
P7_rs_us2      ........................................................................................................................
P8_rs_pr4      ........................................................................................................................
P9_rs_pr5      ........................................................................................................................
P10_cn_jl1     ........................................................................................................................
P10_cn_jl2     ........................................................................................................................
P11_cn_jl3     ........................................................................................................................
P11_cn_jl4     ........................................................................................................................
P12_cn_sn1     ........................................................................................................................
P12_cn_sn2     ........................................................................................................................
P13_cn_mc1     ........................................................................................................................
P13_cn_mc2     ........................................................................................................................
P14_kr_hw1     ........................................................................................................................
P14_kr_hw2     ........................................................................................................................
P15_kr_dm1     ........................................................................................................................
P15_kr_dm2     ........................................................................................................................
P15_kr_dm3     ........................................................................................................................
P16_kr_sk1     ........................................................................................................................
P16_kr_sk2     ........................................................................................................................
P16_kr_sk3     ........................................................................................................................
P16_kr_sk4     ........................................................................................................................
P16_kr_sk5     ........................................................................................................................
P16_kr_sk6     ........................................................................................................................
P16_kr_sk7     ........................................................................................................................
P16_kr_sk8     ........................................................................................................................
P17_kr_sh1     ........................................................................................................................
P18_kr_gb1     ........................................................................................................................
P19_kr_gw1     ........................................................................................................................
P19_kr_gw2     ........................................................................................................................
P19_kr_gw3     ........................................................................................................................
P20_kr_ck1     ........................................................................................................................
P20_kr_ck2     ........................................................................................................................
P21_kr_hc1     ........................................................................................................................
P22_kr_hb1     ........................................................................................................................
P23_kr_hb2     ........................................................................................................................
P24_kr_mh1     ........................................................................................................................
P24_kr_mh2     ........................................................................................................................
p25_kr_tb1     ........................................................................................................................
p25_kr_tb2     ........................................................................................................................
P26_kr_tb3     ........................................................................................................................
P27_kr_so1     ........................................................................................................................
P27_kr_so2     ........................................................................................................................
P27_kr_so3     ........................................................................................................................
P27_kr_so4     ........................................................................................................................
P27_kr_so5     ........................................................................................................................
P27_kr_so6     ........................................................................................................................
P28_kr_il1     ........................................................................................................................
P29_kr_mj1     ........................................................................................................................
P29_kr_mj2     ........................................................................................................................
P30_kr_dk1     ........................................................................................................................
P31_kr_jr1     ........................................................................................................................
P32_kr_jr2     ........................................................................................................................
O1_jp_rb1      ........................................................................................................................
O2_jp_hk1      ........................................................................................................................
O2_jp_hk2      ........................................................................................................................
O2_jp_hk3      ........................................................................................................................
O2_jp_hk4      ........................................................................................................................
J1_jp_hn1      ........................................................................................................................
J1_jp_hn2      ........................................................................................................................
J2_jp_ky1      ........................................................................................................................
J3_jp_jp1      ........................................................................................................................
B1_cn_bj1      ........................................................................................................................
B2_uk_1        ........................................................................................................................
AMP_cn_1       ..............................................................................................................A.CCA.....
SUF_kr_hl1     ..............................................................................................................A.........
SUF_kr_hl2     ..............................................................................................................A.........
```

Appendix 2. (Continued).

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                                                                                                                                   1920
A1_kr_gr1      TGGCTAAAGCATCGGAGCGGGACTTCTTCTTTTTCCGACAACAACAACAAATCTTCGTCGTATATGGGCTTTTCCTAGTATTTCGTTATTGAGTTTAGTTATGCTTTTTTCAATGAACTT
A1_kr_gr2      ........................................................................................................................
A2_kr_hl1      ........................................................................................................................
A2_kr_hl2      ........................................................................................................................
A2_kr_hl3      ........................................................................................................................
A2_kr_hl4      ........................................................................................................................
A3_kr_hl5      ........................................................................................................................
A3_kr_hl6      ........................................................................................................................
A3_kr_hl7      ........................................................................................................................
A3_kr_hl8      ........................................................................................................................
A4_kr_hl9      ........................................................................................................................
A5_kr_hl10     ........................................................................................................................
A5_kr_hl11     ........................................................................................................................
A5_kr_hl12     ........................................................................................................................
A5_kr_hl13     ........................................................................................................................
A5_kr_hl14     ........................................................................................................................
A7_mn_1        ........................................................................................................................
A8_mn_2        ........................................................................................................................
M1_rs_kb1      ........................................................................................................................
M2_rs_kh1      ........................................................................................................................
M2_rs_kh2      ........................................................................................................................
M2_rs_kh3      ........................................................................................................................
M3_rs_kh4      ........................................................................................................................
M3_rs_kh5      ........................................................................................................................
M3_rs_kh6      ........................................................................................................................
M3_rs_kh7      ........................................................................................................................
M3_rs_kh8      ........................................................................................................................
M3_rs_kh9      ........................................................................................................................
M3_rs_kh10     ........................................................................................................................
M3_rs_kh11     ........................................................................................................................
M3_rs_kh12     ........................................................................................................................
M3_rs_kh13     ........................................................................................................................
M3_rs_kh14     ........................................................................................................................
M3_rs_kh15     ........................................................................................................................
M3_rs_kh16     ........................................................................................................................
M3_rs_kh17     ........................................................................................................................
M3_rs_kh18     ........................................................................................................................
M3_rs_kh19     ........................................................................................................................
M3_rs_kh20     ........................................................................................................................
M3_rs_kh21     ........................................................................................................................
M3_rs_kh22     ........................................................................................................................
M3_rs_kh23     ........................................................................................................................
M3_rs_kh24     ........................................................................................................................
M3_rs_kh25     ........................................................................................................................
M3_rs_kh26     ........................................................................................................................
M3_rs_kh27     ........................................................................................................................
M3_rs_kh28     ........................................................................................................................
M3_rs_kh29     ........................................................................................................................
M3_rs_kh30     ........................................................................................................................
M3_rs_kh31     ........................................................................................................................
M4_rs_kh32     ........................................................................................................................
M5_rs_ot1      ........................................................................................................................
M6_rs_ri1      ........................................................................................................................
M6_rs_ri2      ........................................................................................................................
M7_cn_hj1      ........................................................................................................................
M8_cn_hj2      ........................................................................................................................
M8_cn_hj3      ........................................................................................................................
M8_cn_hj4      ........................................................................................................................
M9_cn_hj5      ........................................................................................................................
M10_cn_nm1     ........................................................................................................................
M11_cn_ul1     ........................................................................................................................
M12_cn_sb1     ........................................................................................................................
M12_cn_sb2     ........................................................................................................................
M13_kr_od1     ........................................................................................................................
M14_kr_jm1     ........................................................................................................................
M14_kr_jm2     ........................................................................................................................
M14_kr_jm3     ........................................................................................................................
M15_kr_dg1     ........................................................................................................................
M16_kr_dr1     ........................................................................................................................
M17_kr_sw1     ........................................................................................................................
M17_kr_sw2     ........................................................................................................................
M18_kr_hg1     ........................................................................................................................
M19_kr_gy1     ........................................................................................................................
M20_kr_nh1     ........................................................................................................................
M20_kr_nh2     ........................................................................................................................
M21_kr_gu1     ........................................................................................................................
M22_kr_mp1     ........................................................................................................................
M23_kr_bc1     ........................................................................................................................
M24_kr_os1     ........................................................................................................................
M25_kr_os2     ........................................................................................................................
M25_kr_os3     ........................................................................................................................
M25_kr_os4     ........................................................................................................................
M25_kr_os5     ........................................................................................................................
M26_kr_sn1     ........................................................................................................................
M27_kr_gn1     ........................................................................................................................
M27_kr_gn2     ........................................................................................................................
M28_kr_bs1     ........................................................................................................................
M28_kr_bs2     ........................................................................................................................
M28_kr_bs3     ........................................................................................................................
M29_kr_jn1     ........................................................................................................................
M30_kr_bl1     ........................................................................................................................
M30_kr_bl2     ........................................................................................................................
M31_kr_jl1     ........................................................................................................................
M31_kr_jl2     ........................................................................................................................
M32_kr_mt1     ........................................................................................................................
M33_kr_md1     ........................................................................................................................
M33_kr_md2     ........................................................................................................................
```

Appendix 2. (Continued).

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                                                                                                                                   1920
A1_kr_gr1      TGGCTAAAGCATCGGAGCGGGACTTCTTCTTTTTCCGACAACAACAACAAATCTTCGTCGTATATGGGCTTTTCCTAGTATTTCGTTATTGAGTTTAGTTATGCTTTTTTCAATGAACTT
M34_kr_dn1     ........................................................................................................................
M34_kr_dn2     ........................................................................................................................
M35_kr_sm1     ........................................................................................................................
M35_kr_sm2     ........................................................................................................................
P1_rs_ms1      ........................................................................................................................
P1_rs_ms2      ........................................................................................................................
P1_rs_ms3      ........................................................................................................................
P1_rs_ms4      ........................................................................................................................
P2_rs_nk1      ........................................................................................................................
P2_rs_nk2      ........................................................................................................................
P3_rs_pr1      ........................................................................................................................
P4_rs_pr2      ........................................................................................................................
P4_rs_pr3      ........................................................................................................................
P5_rs_rc1      ........................................................................................................................
P5_rs_rc2      ........................................................................................................................
P5_rs_rc3      ........................................................................................................................
P6_rs_rc4      ........................................................................................................................
P6_rs_rc5      ........................................................................................................................
P6_rs_rc6      ........................................................................................................................
P6_rs_rc7      ........................................................................................................................
P6_rs_rc8      ........................................................................................................................
P7_rs_us1      ........................................................................................................................
P7_rs_us2      ........................................................................................................................
P8_rs_pr4      ........................................................................................................................
P9_rs_pr5      ........................................................................................................................
P10_cn_jl1     ........................................................................................................................
P10_cn_jl2     ........................................................................................................................
P11_cn_jl3     ........................................................................................................................
P11_cn_jl4     ........................................................................................................................
P12_cn_sn1     ........................................................................................................................
P12_cn_sn2     ........................................................................................................................
P13_cn_mc1     ........................................................................................................................
P13_cn_mc2     ........................................................................................................................
P14_kr_hw1     ........................................................................................................................
P14_kr_hw2     ........................................................................................................................
P15_kr_dm1     ........................................................................................................................
P15_kr_dm2     ........................................................................................................................
P15_kr_dm3     ........................................................................................................................
P16_kr_sk1     ........................................................................................................................
P16_kr_sk2     ........................................................................................................................
P16_kr_sk3     ........................................................................................................................
P16_kr_sk4     ........................................................................................................................
P16_kr_sk5     ........................................................................................................................
P16_kr_sk6     ........................................................................................................................
P16_kr_sk7     ........................................................................................................................
P16_kr_sk8     ........................................................................................................................
P17_kr_sh1     ........................................................................................................................
P18_kr_gb1     ........................................................................................................................
P19_kr_gw1     ........................................................................................................................
P19_kr_gw2     ........................................................................................................................
P19_kr_gw3     ........................................................................................................................
P20_kr_ck1     ........................................................................................................................
P20_kr_ck2     ........................................................................................................................
P21_kr_hc1     ........................................................................................................................
P22_kr_hb1     ........................................................................................................................
P23_kr_hb2     ........................................................................................................................
P28_kr_il1     ........................................................................................................................
P24_kr_mh1     ........................................................................................................................
P24_kr_mh2     ........................................................................................................................
p25_kr_tb1     ........................................................................................................................
p25_kr_tb2     ........................................................................................................................
P26_kr_tb3     ........................................................................................................................
P27_kr_so1     ........................................................................................................................
P27_kr_so2     ........................................................................................................................
P27_kr_so3     ........................................................................................................................
P27_kr_so4     ........................................................................................................................
P27_kr_so5     ........................................................................................................................
P27_kr_so6     ........................................................................................................................
P29_kr_mj1     ........................................................................................................................
P29_kr_mj2     ........................................................................................................................
P30_kr_dk1     ........................................................................................................................
P31_kr_jr1     ........................................................................................................................
P32_kr_jr2     ........................................................................................................................
O1_jp_rb1      ........................................................................................................................
O2_jp_hk1      ........................................................................................................................
O2_jp_hk2      ........................................................................................................................
O2_jp_hk3      ........................................................................................................................
O2_jp_hk4      ........................................................................................................................
J1_jp_hn1      ........................................................................................................................
J1_jp_hn2      ........................................................................................................................
J2_jp_ky1      ........................................................................................................................
J3_jp_jp1      ........................................................................................................................
B1_cn_bj1      ........................................................................................................................
B2_uk_1        ........................................................................................................................
AMP_cn_1       ..............................................................................................C.........................
SUF_kr_hl1     ..............................................................................................C...................T.....
SUF_kr_hl2     ..............................................................................................C...................T.....
```

Appendix 2. (Continued).

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                                                                                                                                  2040
A1_kr_gr1      GTCTATTCAACAAATAAATAGCAATTCTATCTACCAATCCGTATGGTCTTGGACCATCAATAATGATTTTTCTTTAGAGTTCGGTTACTTGGTTGATCCGCTTACTTCTATTATGTCAAT
A1_kr_gr2      ....................................................................................................................T...
A2_kr_hl1      ................................................................................................C.......................
A2_kr_hl2      ........................................................................................................................
A2_kr_hl3      ....................................................................................................................T...
A2_kr_hl4      ........................................................................................................................
A3_kr_hl5      ....................................................................................................................T...
A3_kr_hl6      ....................................................................................................................T...
A3_kr_hl7      ........................................................................................................................
A3_kr_hl8      ........................................................................................................................
A4_kr_hl9      ........................................................................................................................
A5_kr_hl10     ....................................................................................................................T...
A5_kr_hl11     ....................................................................................................................T...
A5_kr_hl12     ....................................................................................................................T...
A5_kr_hl13     ....................................................................................................................T...
A5_kr_hl14     ....................................................................................................................T...
A7_mn_1        ....................................................................................................................T...
A8_mn_2        ....................................................................................................................T...
M1_rs_kb1      ...........................................G........................................................................T...
M2_rs_kh1      ....................................................................................................................T...
M2_rs_kh2      ....................................................................................................................T...
M2_rs_kh3      ....................................................................................................................T...
M3_rs_kh4      ....................................................................................................................T...
M3_rs_kh5      ....................................................................................................................T...
M3_rs_kh6      ........................................................................................................................
M3_rs_kh7      ........................................................................................................................
M3_rs_kh8      ....................................................................................................................T...
M3_rs_kh9      ........................................................................................................................
M3_rs_kh10     ........................................................................................................................
M3_rs_kh11     ........................................................................................................................
M3_rs_kh12     ........................................................................................................................
M3_rs_kh13     ........................................................................................................................
M3_rs_kh14     ........................................................................................................................
M3_rs_kh15     ....................................................................................................................T...
M3_rs_kh16     ....................................................................................................................T...
M3_rs_kh17     ....................................................................................................................T...
M3_rs_kh18     ........................................................................................................................
M3_rs_kh19     ....................................................................................................................T...
M3_rs_kh20     ........................................................................................................................
M3_rs_kh21     ....................................................................................................................T...
M3_rs_kh22     ....................................................................................................................T...
M3_rs_kh23     ........................................................................................................................
M3_rs_kh24     ....................................................................................................................T...
M3_rs_kh25     ....................................................................................................................T...
M3_rs_kh26     ........................................................................................................................
M3_rs_kh27     ....................................................................................................................T...
M3_rs_kh28     ....................................................................................................................T...
M3_rs_kh29     ....................................................................................................................T...
M3_rs_kh30     ........................................................................................................................
M3_rs_kh31     ....................................................................................................................T...
M4_rs_kh32     ....................................................................................................................T...
M5_rs_ot1      ........................................................................................................................
M6_rs_ri1      ........................................................................................................................
M6_rs_ri2      ....................................................................................................................T...
M7_cn_hj1      ........................................................................................................................
M8_cn_hj2      ....................................................................................................................T...
M8_cn_hj3      ....................................................................................................................T...
M8_cn_hj4      ....................................................................................................................T...
M9_cn_hj5      ....................................................................................................................T...
M10_cn_nm1     ....................................................................................................................T...
M11_cn_ul1     ....................................................................................................................T...
M12_cn_sb1     ....................................................................................................................T...
M12_cn_sb2     ....................................................................................................................T...
M13_kr_od1     ....................................................................................................................T...
M14_kr_jm1     ........................................................................................................................
M14_kr_jm2     ........................................................................................................................
M14_kr_jm3     ........................................................................................................................
M15_kr_dg1     ........................................................................................................................
M16_kr_dr1     ....................................................................................................................T...
M17_kr_sw1     ........................................................................................................................
M17_kr_sw2     ........................................................................................................................
M18_kr_hg1     ....................................................................................................................T...
M19_kr_gy1     ....................................................................................................................T...
M20_kr_nh1     ........................................................................................................................
M20_kr_nh2     ........................................................................................................................
M21_kr_gu1     ....................................................................................................................T...
M22_kr_mp1     ....................................................................................................................T...
M23_kr_bc1     ....................................................................................................................T...
M24_kr_os1     ....................................................................................................................T...
M25_kr_os2     ....................................................................................................................T...
M25_kr_os3     ........................................................................................................................
M25_kr_os4     ....................................................................................................................T...
M25_kr_os5     ....................................................................................................................T...
M26_kr_sn1     ....................................................................................................................T...
M27_kr_gn1     ....................................................................................................................T...
M27_kr_gn2     ....................................................................................................................T...
M28_kr_bs1     ........................................................................................................................
M28_kr_bs2     ....................................................................................................................T...
M28_kr_bs3     ........................................................................................................................
M29_kr_jn1     ....................................................................................................................T...
M30_kr_bl1     ....................................................................................................................T...
M30_kr_bl2     ........................................................................................................................
M31_kr_jl1     ........................................................................................................................
M31_kr_jl2     ....................................................................................................................T...
M32_kr_mt1     ....................................................................................................................T...
M33_kr_md1     ....................................................................................................................T...
M33_kr_md2     ....................................................................................................................T...
```

Appendix 2. (Continued).

```
                                                                                                                                  2040
A1_kr_gr1      GTCTATTCAACAAATAAATAGCAATTCTATCTACCAATCCGTATGGTCTTGGACCATCAATAATGATTTTTCTTTAGAGTTCGGTTACTTGGTTGATCCGCTTACTTCTATTATGTCAAT
M34_kr_dn1     ....................................................................................................................T...
M34_kr_dn2     ....................................................................................................................T...
M35_kr_sm1     ...........................................G............................................................................T...
M35_kr_sm2     ...........................................G............................................................................T...
P1_rs_ms1      ....................................................................................................................T...
P1_rs_ms2      ....................................................................................................................T...
P1_rs_ms3      ....................................................................................................................T...
P1_rs_ms4      ....................................................................................................................T...
P2_rs_nk1      ....................................................................................................................T...
P2_rs_nk2      ....................................................................................................................T...
P3_rs_pr1      ....................................................................................................................T...
P4_rs_pr2      ....................................................................................................................T...
P4_rs_pr3      ........................................................................................................................
P5_rs_rc1      ........................................................................................................................
P5_rs_rc2      ....................................................................................................................T...
P5_rs_rc3      ....................................................................................................................T...
P6_rs_rc4      ........................................................................................................................
P6_rs_rc5      ........................................................................................................................
P6_rs_rc6      ........................................................................................................................
P6_rs_rc7      ........................................................................................................................
P6_rs_rc8      ....................................................................................................................T...
P7_rs_us1      ....................................................................................................................T...
P7_rs_us2      ....................................................................................................................T...
P8_rs_pr4      ....................................................................................................................T...
P9_rs_pr5      ........................................................................................................................
P10_cn_jl1     ....................................................................................................................T...
P10_cn_jl2     ....................................................................................................................T...
P11_cn_jl3     ....................................................................................................................T...
P11_cn_jl4     ....................................................................................................................T...
P12_cn_sn1     ....................................................................................................................T...
P12_cn_sn2     ....................................................................................................................T...
P13_cn_mc1     ....................................................................................................................T...
P13_cn_mc2     ....................................................................................................................T...
P14_kr_hw1     ....................................................................................................................T...
P14_kr_hw2     ....................................................................................................................T...
P15_kr_dm1     ........................................................................................................................
P15_kr_dm2     ........................................................................................................................
P15_kr_dm3     ........................................................................................................................
P16_kr_sk1     ....................................................................................................................T...
P16_kr_sk2     ....................................................................................................................T...
P16_kr_sk3     ....................................................................................................................T...
P16_kr_sk4     ....................................................................................................................T...
P16_kr_sk5     ....................................................................................................................T...
P16_kr_sk6     ....................................................................................................................T...
P16_kr_sk7     ....................................................................................................................T...
P16_kr_sk8     ....................................................................................................................T...
P17_kr_sh1     ........................................................................................................................
P18_kr_gb1     ....................................................................................................................T...
P19_kr_gw1     ....................................................................................................................T...
P19_kr_gw2     ....................................................................................................................T...
P19_kr_gw3     ....................................................................................................................T...
P20_kr_ck1     ....................................................................................................................T...
P20_kr_ck2     ....................................................................................................................T...
P21_kr_hc1     ....................................................................................................................T...
P22_kr_hb1     ....................................................................................................................T...
P23_kr_hb2     ....................................................................................................................T...
P24_kr_mh1     ....................................................................................................................T...
P24_kr_mh2     ....................................................................................................................T...
p25_kr_tb1     ....................................................................................................................T...
p25_kr_tb2     ....................................................................................................................T...
P26_kr_tb3     ....................................................................................................................T...
P27_kr_so1     ....................................................................................................................T...
P27_kr_so2     ....................................................................................................................T...
P27_kr_so3     ....................................................................................................................T...
P27_kr_so4     ....................................................................................................................T...
P27_kr_so5     ....................................................................................................................T...
P27_kr_so6     ....................................................................................................................T...
P28_kr_il1     ....................................................................................................................T...
P29_kr_mj1     ....................................................................................................................T...
P29_kr_mj2     ....................................................................................................................T...
P30_kr_dk1     ....................................................................................................................T...
P31_kr_jr1     ....................................................................................................................T...
P32_kr_jr2     ....................................................................................................................T...
O1_jp_rb1      ....................................................................................................................T...
O2_jp_hk1      ....................................................................................................................T...
O2_jp_hk2      ....................................................................................................................T...
O2_jp_hk3      ....................................................................................................................T...
O2_jp_hk4      ....................................................................................................................T...
J1_jp_hn1      ....................................................................................................................T...
J1_jp_hn2      ....................................................................................................................T...
J2_jp_ky1      ........................................................................................................................
J3_jp_jp1      ....................................................................................................................T...
B1_cn_bj1      ........................................................................................................................
B2_uk_1        ........................................................................................................................
AMP_cn_1       ........................................................................................................................
SUF_kr_hl1     .................................................................................................................C......
SUF_kr_hl2     .................................................................................................................C......
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Appendix 2. (Continued).

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                                                                                                                                  2160
A1_kr_gr1      GTTAATCACTACTGTTGGTATTCTAGTTCTTATTTATAGTGACAGTTATATGTCTCATGATCAAGGATATTTAAGATTCTTTGCTTATCTGAGTTTTTTCAATACTTCTATGCTTGGCTT
A1_kr_gr2      ........................................................................................................................
A2_kr_hl1      ........................................................................................................................
A2_kr_hl2      ........................................................................................................................
A2_kr_hl3      ........................................................................................................................
A2_kr_hl4      ........................................................................................................................
A3_kr_hl5      ........................................................................................................................
A3_kr_hl6      ........................................................................................................................
A3_kr_hl7      ........................................................................................................................
A3_kr_hl8      ........................................................................................................................
A4_kr_hl9      ........................................................................................................................
A5_kr_hl10     ........................................................................................................................
A5_kr_hl11     ........................................................................................................................
A5_kr_hl12     ........................................................................................................................
A5_kr_hl13     ........................................................................................................................
A5_kr_hl14     ........................................................................................................................
A7_mn_1        ........................................................................................................................
A8_mn_2        ........................................................................................................................
M1_rs_kb1      ........................................................................................................................
M2_rs_kh1      ........................................................................................................................
M2_rs_kh2      ........................................................................................................................
M2_rs_kh3      ........................................................................................................................
M3_rs_kh4      ........................................................................................................................
M3_rs_kh5      ........................................................................................................................
M3_rs_kh6      ........................................................................................................................
M3_rs_kh7      ........................................................................................................................
M3_rs_kh8      ........................................................................................................................
M3_rs_kh9      ........................................................................................................................
M3_rs_kh10     ........................................................................................................................
M3_rs_kh11     ........................................................................................................................
M3_rs_kh12     ........................................................................................................................
M3_rs_kh13     ........................................................................................................................
M3_rs_kh14     ........................................................................................................................
M3_rs_kh15     ........................................................................................................................
M3_rs_kh16     ........................................................................................................................
M3_rs_kh17     ........................................................................................................................
M3_rs_kh18     ........................................................................................................................
M3_rs_kh19     ........................................................................................................................
M3_rs_kh20     ........................................................................................................................
M3_rs_kh21     ........................................................................................................................
M3_rs_kh22     ........................................................................................................................
M3_rs_kh23     ........................................................................................................................
M3_rs_kh24     ........................................................................................................................
M3_rs_kh25     ........................................................................................................................
M3_rs_kh26     ........................................................................................................................
M3_rs_kh27     ........................................................................................................................
M3_rs_kh28     ........................................................................................................................
M3_rs_kh29     ........................................................................................................................
M3_rs_kh30     ........................................................................................................................
M3_rs_kh31     ........................................................................................................................
M4_rs_kh32     ........................................................................................................................
M5_rs_ot1      ........................................................................................................................
M6_rs_ri1      ........................................................................................................................
M6_rs_ri2      ........................................................................................................................
M7_cn_hj1      ........................................................................................................................
M8_cn_hj2      ........................................................................................................................
M8_cn_hj3      ........................................................................................................................
M8_cn_hj4      ........................................................................................................................
M9_cn_hj5      ........................................................................................................................
M10_cn_nm1     ........................................................................................................................
M11_cn_ul1     ........................................................................................................................
M12_cn_sb1     ........................................................................................................................
M12_cn_sb2     ........................................................................................................................
M13_kr_od1     ........................................................................................................................
M14_kr_jm1     ........................................................................................................................
M14_kr_jm2     ........................................................................................................................
M14_kr_jm3     ........................................................................................................................
M15_kr_dg1     ........................................................................................................................
M16_kr_dr1     ........................................................................................................................
M17_kr_sw1     ........................................................................................................................
M17_kr_sw2     ........................................................................................................................
M18_kr_hg1     ........................................................................................................................
M19_kr_gy1     ........................................................................................................................
M20_kr_nh1     ........................................................................................................................
M20_kr_nh2     ........................................................................................................................
M21_kr_gu1     ........................................................................................................................
M22_kr_mp1     ........................................................................................................................
M23_kr_bc1     ........................................................................................................................
M24_kr_os1     ........................................................................................................................
M25_kr_os2     ........................................................................................................................
M25_kr_os3     ........................................................................................................................
M25_kr_os4     ........................................................................................................................
M25_kr_os5     ........................................................................................................................
M26_kr_sn1     ........................................................................................................................
M27_kr_gn1     ........................................................................................................................
M27_kr_gn2     ........................................................................................................................
M28_kr_bs1     ........................................................................................................................
M28_kr_bs2     ........................................................................................................................
M28_kr_bs3     ........................................................................................................................
M29_kr_jn1     ........................................................................................................................
M30_kr_bl1     ........................................................................................................................
M30_kr_bl2     ........................................................................................................................
M31_kr_jl1     ........................................................................................................................
M31_kr_jl2     ........................................................................................................................
M32_kr_mt1     ........................................................................................................................
M33_kr_md1     ........................................................................................................................
M33_kr_md2     ........................................................................................................................
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Appendix 2. (Continued).

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                                                                                                                                   2160
A1_kr_gr1      GTTAATCACTACTGTTGGTATTCTAGTTCTTATTTATAGTGACAGTTATATGTCTCATGATCAAGGATATTTAAGATTCTTTGCTTATCTGAGTTTTTTCAATACTTCTATGCTTGGCTT
M34_kr_dn1     ........................................................................................................................
M34_kr_dn2     ........................................................................................................................
M35_kr_sm1     ........................................................................................................................
M35_kr_sm2     ........................................................................................................................
P1_rs_ms1      ........................................................................................................................
P1_rs_ms2      ........................................................................................................................
P1_rs_ms3      ........................................................................................................................
P1_rs_ms4      ........................................................................................................................
P2_rs_nk1      ........................................................................................................................
P2_rs_nk2      ........................................................................................................................
P3_rs_pr1      ........................................................................................................................
P4_rs_pr2      ........................................................................................................................
P4_rs_pr3      ........................................................................................................................
P5_rs_rc1      ........................................................................................................................
P5_rs_rc2      ........................................................................................................................
P5_rs_rc3      ........................................................................................................................
P6_rs_rc4      ........................................................................................................................
P6_rs_rc5      ........................................................................................................................
P6_rs_rc6      ........................................................................................................................
P6_rs_rc7      ........................................................................................................................
P6_rs_rc8      ........................................................................................................................
P7_rs_us1      ........................................................................................................................
P7_rs_us2      ........................................................................................................................
P8_rs_pr4      ........................................................................................................................
P9_rs_pr5      ........................................................................................................................
P10_cn_jl1     ........................................................................................................................
P10_cn_jl2     ........................................................................................................................
P11_cn_jl3     ........................................................................................................................
P11_cn_jl4     ........................................................................................................................
P12_cn_sn1     ........................................................................................................................
P12_cn_sn2     ........................................................................................................................
P13_cn_mc1     ........................................................................................................................
P13_cn_mc2     ........................................................................................................................
P14_kr_hw1     ........................................................................................................................
P14_kr_hw2     ........................................................................................................................
P15_kr_dm1     ........................................................................................................................
P15_kr_dm2     ........................................................................................................................
P15_kr_dm3     ........................................................................................................................
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P16_kr_sk5     ........................................................................................................................
P16_kr_sk6     ........................................................................................................................
P16_kr_sk7     ........................................................................................................................
P16_kr_sk8     ........................................................................................................................
P17_kr_sh1     ........................................................................................................................
P18_kr_gb1     ........................................................................................................................
P19_kr_gw1     ........................................................................................................................
P19_kr_gw2     ........................................................................................................................
P19_kr_gw3     ........................................................................................................................
P20_kr_ck1     ........................................................................................................................
P20_kr_ck2     ........................................................................................................................
P21_kr_hc1     ........................................................................................................................
P22_kr_hb1     ........................................................................................................................
P23_kr_hb2     ........................................................................................................................
P24_kr_mh1     ........................................................................................................................
P24_kr_mh2     ........................................................................................................................
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P26_kr_tb3     ........................................................................................................................
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P27_kr_so2     ........................................................................................................................
P27_kr_so3     ........................................................................................................................
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P27_kr_so5     ........................................................................................................................
P27_kr_so6     ........................................................................................................................
P28_kr_il1     ........................................................................................................................
P29_kr_mj1     ........................................................................................................................
P29_kr_mj2     ........................................................................................................................
P30_kr_dk1     ........................................................................................................................
P31_kr_jr1     ........................................................................................................................
P32_kr_jr2     ........................................................................................................................
O1_jp_rb1      ........................................................................................................................
O2_jp_hk1      ........................................................................................................................
O2_jp_hk2      ........................................................................................................................
O2_jp_hk3      ........................................................................................................................
O2_jp_hk4      ........................................................................................................................
J1_jp_hn1      ........................................................................................................................
J1_jp_hn2      ........................................................................................................................
J2_jp_ky1      ........................................................................................................................
J3_jp_jp1      ........................................................................................................................
B1_cn_bj1      ........................................................................................................................
B2_uk_1        ........................................................................................................................
AMP_cn_1       ............................A...........................................................................................
SUF_kr_hl1     .........................................................................................................C..............
SUF_kr_hl2     .........................................................................................................C..............
```

Appendix 2. (Continued).

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                                                                                                                                          2280
A1_kr_gr1      AGTTACAAGTTCGAATTTACTACAAATTTATATTTTTTGGGAATTAGTTGGGATGTGCTCGTATCTATTAATAGGTTTTTGGTTTACACGACCTATTGCAGCAAATGCTTGTCAAAAAGC
A1_kr_gr2      ........................................................................................................................
A2_kr_hl1      ........................................................................................................................
A2_kr_hl2      ........................................................................................................................
A2_kr_hl3      ........................................................................................................................
A2_kr_hl4      ........................................................................................................................
A3_kr_hl5      ........................................................................................................................
A3_kr_hl6      ........................................................................................................................
A3_kr_hl7      ........................................................................................................................
A3_kr_hl8      ........................................................................................................................
A4_kr_hl9      ........................................................................................................................
A5_kr_hl10     ........................................................................................................................
A5_kr_hl11     ........................................................................................................................
A5_kr_hl12     ........................................................................................................................
A5_kr_hl13     ........................................................................................................................
A5_kr_hl14     ........................................................................................................................
A7_mn_1        ........................................................................................................................
A8_mn_2        ........................................................................................................................
M1_rs_kb1      ........................................................................................................................
M2_rs_kh1      ........................................................................................................................
M2_rs_kh2      ........................................................................................................................
M2_rs_kh3      ........................................................................................................................
M3_rs_kh4      ........................................................................................................................
M3_rs_kh5      ........................................................................................................................
M3_rs_kh6      ........................................................................................................................
M3_rs_kh7      ........................................................................................................................
M3_rs_kh8      ........................................................................................................................
M3_rs_kh9      ........................................................................................................................
M3_rs_kh10     ........................................................................................................................
M3_rs_kh11     ........................................................................................................................
M3_rs_kh12     ........................................................................................................................
M3_rs_kh13     ........................................................................................................................
M3_rs_kh14     ........................................................................................................................
M3_rs_kh15     ........................................................................................................................
M3_rs_kh16     ........................................................................................................................
M3_rs_kh17     ........................................................................................................................
M3_rs_kh18     ........................................................................................................................
M3_rs_kh19     ........................................................................................................................
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M3_rs_kh23     ........................................................................................................................
M3_rs_kh24     ........................................................................................................................
M3_rs_kh25     ........................................................................................................................
M3_rs_kh26     ........................................................................................................................
M3_rs_kh27     ........................................................................................................................
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M4_rs_kh32     ........................................................................................................................
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M6_rs_ri1      ........................................................................................................................
M6_rs_ri2      ........................................................................................................................
M8_cn_hj2      ........................................................................................................................
M8_cn_hj3      ........................................................................................................................
M8_cn_hj4      ........................................................................................................................
M7_cn_hj1      ........................................................................................................................
M9_cn_hj5      ........................................................................................................................
M10_cn_nm1     ........................................................................................................................
M11_cn_ul1     ........................................................................................................................
M12_cn_sb1     ........................................................................................................................
M12_cn_sb2     ........................................................................................................................
M13_kr_od1     ........................................................................................................................
M14_kr_jm1     ........................................................................................................................
M14_kr_jm2     ........................................................................................................................
M14_kr_jm3     ........................................................................................................................
M15_kr_dg1     ........................................................................................................................
M16_kr_dr1     ........................................................................................................................
M17_kr_sw1     ........................................................................................................................
M17_kr_sw2     ........................................................................................................................
M18_kr_hg1     ........................................................................................................................
M19_kr_gy1     ........................................................................................................................
M20_kr_nh1     ........................................................................................................................
M20_kr_nh2     ........................................................................................................................
M21_kr_gu1     ........................................................................................................................
M22_kr_mp1     ........................................................................................................................
M23_kr_bc1     ........................................................................................................................
M24_kr_os1     ........................................................................................................................
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M27_kr_gn1     ........................................................................................................................
M27_kr_gn2     ........................................................................................................................
M28_kr_bs1     ........................................................................................................................
M28_kr_bs2     ........................................................................................................................
M28_kr_bs3     ........................................................................................................................
M29_kr_jn1     ........................................................................................................................
M30_kr_bl1     ........................................................................................................................
M30_kr_bl2     ........................................................................................................................
M31_kr_jl1     ........................................................................................................................
M31_kr_jl2     ........................................................................................................................
M32_kr_mt1     ........................................................................................................................
M33_kr_md1     ........................................................................................................................
M33_kr_md2     ........................................................................................................................
```

Appendix 2. (Continued).

```
                                                                                                                                   2280
A1_kr_gr1      AGTTACAAGTTCGAATTTACTACAAATTTATATTTTTTGGGAATTAGTTGGGATGTGCTCGTATCTATTAATAGGTTTTTGGTTTACACGACCTATTGCAGCAAATGCTTGTCAAAAAGC
M34_kr_dn1     ........................................................................................................................
M34_kr_dn2     ........................................................................................................................
M35_kr_sm1     ........................................................................................................................
M35_kr_sm2     ........................................................................................................................
P1_rs_ms1      ........................................................................................................................
P1_rs_ms2      ........................................................................................................................
P1_rs_ms3      ........................................................................................................................
P1_rs_ms4      ........................................................................................................................
P2_rs_nk1      ........................................................................................................................
P2_rs_nk2      ........................................................................................................................
P3_rs_pr1      ........................................................................................................................
P4_rs_pr2      ........................................................................................................................
P4_rs_pr3      ........................................................................................................................
P5_rs_rc1      ........................................................................................................................
P5_rs_rc2      ........................................................................................................................
P5_rs_rc3      ........................................................................................................................
P6_rs_rc4      ........................................................................................................................
P6_rs_rc5      ........................................................................................................................
P6_rs_rc6      ........................................................................................................................
P6_rs_rc7      ........................................................................................................................
P6_rs_rc8      ........................................................................................................................
P7_rs_us1      ........................................................................................................................
P7_rs_us2      ........................................................................................................................
P8_rs_pr4      ........................................................................................................................
P9_rs_pr5      ........................................................................................................................
P10_cn_jl1     ........................................................................................................................
P10_cn_jl2     ........................................................................................................................
P11_cn_jl3     ........................................................................................................................
P11_cn_jl4     ........................................................................................................................
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P12_cn_sn2     ........................................................................................................................
P13_cn_mc1     ........................................................................................................................
P13_cn_mc2     ........................................................................................................................
P14_kr_hw1     ........................................................................................................................
P14_kr_hw2     ........................................................................................................................
P15_kr_dm1     ........................................................................................................................
P15_kr_dm2     ........................................................................................................................
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P19_kr_gw2     ........................................................................................................................
P19_kr_gw3     ........................................................................................................................
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P20_kr_ck2     ........................................................................................................................
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P22_kr_hb1     ........................................................................................................................
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P27_kr_so5     ........................................................................................................................
P27_kr_so6     ........................................................................................................................
P28_kr_il1     ........................................................................................................................
P29_kr_mj1     ........................................................................................................................
P29_kr_mj2     ........................................................................................................................
P30_kr_dk1     ........................................................................................................................
P31_kr_jr1     ........................................................................................................................
P32_kr_jr2     ........................................................................................................................
O1_jp_rb1      ........................................................................................................................
O2_jp_hk1      ........................................................................................................................
O2_jp_hk2      ........................................................................................................................
O2_jp_hk3      ........................................................................................................................
O2_jp_hk4      ........................................................................................................................
J1_jp_hn1      ........................................................................................................................
J1_jp_hn2      ........................................................................................................................
J2_jp_ky1      ........................................................................................................................
J3_jp_jp1      ........................................................................................................................
B1_cn_bj1      ........................................................................................................................
B2_uk_1        ........................................................................................................................
AMP_cn_1       ...................................................A....................................................................
SUF_kr_hl1     ............A......................................A....................................................................
SUF_kr_hl2     ............A......................................A....................................................................
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Appendix 2. (Continued).

```
                                                                                                                                   2400
A1_kr_gr1      ATTTGTGACGAATCGTGTAGGGGATTTTGGTTTATTATTAGGAATTTTAGGTCTTTATTGGCTAACGGGCAGTTTCGAATTTCGAGATTTGTTCGAAATATTCAATACCTCCATTTCGAA
A1_kr_gr2      ........................................................................................................................
A2_kr_hl1      ........................................................................................................................
A2_kr_hl2      ........................................................................................................................
A2_kr_hl3      ........................................................................................................................
A2_kr_hl4      ........................................................................................................................
A3_kr_hl5      ........................................................................................................................
A3_kr_hl6      ........................................................................................................................
A3_kr_hl7      ........................................................................................................................
A3_kr_hl8      ........................................................................................................................
A4_kr_hl9      ........................................................................................................................
A5_kr_hl10     ........................................................................................................................
A5_kr_hl11     ........................................................................................................................
A5_kr_hl12     ........................................................................................................................
A5_kr_hl13     ........................................................................................................................
A5_kr_hl14     ........................................................................................................................
A7_mn_1        .....................................................................................................................T..
A8_mn_2        .....................................................................................................................T..
M1_rs_kb1      ..................................................................................A.....................................
M2_rs_kh1      ........................................................................................................................
M2_rs_kh2      ........................................................................................................................
M2_rs_kh3      ........................................................................................................................
M3_rs_kh4      ........................................................................................................................
M3_rs_kh5      ........................................................................................................................
M3_rs_kh6      ........................................................................................................................
M3_rs_kh7      ........................................................................................................................
M3_rs_kh8      ........................................................................................................................
M3_rs_kh9      ........................................................................................................................
M3_rs_kh10     ........................................................................................................................
M3_rs_kh11     ........................................................................................................................
M3_rs_kh12     ........................................................................................................................
M3_rs_kh13     ........................................................................................................................
M3_rs_kh14     ........................................................................................................................
M3_rs_kh15     ........................................................................................................................
M3_rs_kh16     ........................................................................................................................
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M3_rs_kh18     ........................................................................................................................
M3_rs_kh19     ........................................................................................................................
M3_rs_kh20     ........................................................................................................................
M3_rs_kh21     ........................................................................................................................
M3_rs_kh22     ........................................................................................................................
M3_rs_kh23     ........................................................................................................................
M3_rs_kh24     ........................................................................................................................
M3_rs_kh25     ........................................................................................................................
M3_rs_kh26     ........................................................................................................................
M3_rs_kh27     ........................................................................................................................
M3_rs_kh28     ........................................................................................................................
M3_rs_kh29     ........................................................................................................................
M3_rs_kh30     ........................................................................................................................
M3_rs_kh31     ........................................................................................................................
M4_rs_kh32     ........................................................................................................................
M5_rs_ot1      ........................................................................................................................
M6_rs_ri1      ........................................................................................................................
M6_rs_ri2      ........................................................................................................................
M7_cn_hj1      ........................................................................................................................
M8_cn_hj2      ........................................................................................................................
M8_cn_hj3      ........................................................................................................................
M8_cn_hj4      ........................................................................................................................
M9_cn_hj5      ........................................................................................................................
M10_cn_nm1     ........................................................................................................................
M11_cn_ul1     ........................................................................................................................
M12_cn_sb1     ........................................................................................................................
M12_cn_sb2     ........................................................................................................................
M13_kr_od1     ........................................................................................................................
M14_kr_jm1     ........................................................................................................................
M14_kr_jm2     ........................................................................................................................
M14_kr_jm3     ........................................................................................................................
M15_kr_dg1     ........................................................................................................................
M16_kr_dr1     ........................................................................................................................
M17_kr_sw1     ........................................................................................................................
M17_kr_sw2     ........................................................................................................................
M18_kr_hg1     ........................................................................................................................
M19_kr_gy1     ........................................................................................................................
M20_kr_nh1     ........................................................................................................................
M20_kr_nh2     ........................................................................................................................
M21_kr_gu1     ........................................................................................................................
M22_kr_mp1     ........................................................................................................................
M23_kr_bc1     ........................................................................................................................
M24_kr_os1     ........................................................................................................................
M25_kr_os2     ........................................................................................................................
M25_kr_os3     ........................................................................................................................
M25_kr_os4     ........................................................................................................................
M25_kr_os5     ........................................................................................................................
M26_kr_sn1     ........................................................................................................................
M27_kr_gn1     ........................................................................................................................
M27_kr_gn2     ........................................................................................................................
M28_kr_bs1     ........................................................................................................................
M28_kr_bs2     ........................................................................................................................
M28_kr_bs3     ........................................................................................................................
M29_kr_jn1     ........................................................................................................................
M30_kr_bl1     ........................................................................................................................
M30_kr_bl2     ........................................................................................................................
M31_kr_jl1     ........................................................................................................................
M31_kr_jl2     ........................................................................................................................
M32_kr_mt1     ........................................................................................................................
M33_kr_md1     ........................................................................................................................
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Appendix 2. (Continued).

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                                                                                                                                  2400
A1_kr_gr1      ATTTGTGACGAATCGTGTAGGGGATTTTGGTTTATTATTAGGAATTTTAGGTCTTTATTGGCTAACGGGCAGTTTCGAATTTCGAGATTTGTTCGAAATATTCAATACCTCCATTTCGAA
M33_kr_md2     ........................................................................................................................
M34_kr_dn1     ........................................................................................................................
M34_kr_dn2     ........................................................................................................................
M35_kr_sm1     ..................................................................................A.....................................
M35_kr_sm2     ..................................................................................A.....................................
P1_rs_ms1      .....................................................................................................................T..
P1_rs_ms2      .....................................................................................................................T..
P1_rs_ms3      ......................................................................................................A.................
P1_rs_ms4      .....................................................................................................................T..
P2_rs_nk1      .....................................................................................................................T..
P2_rs_nk2      .....................................................................................................................T..
P3_rs_pr1      ........................................................................................................................
P4_rs_pr2      ........................................................................................................................
P4_rs_pr3      ........................................................................................................................
P5_rs_rc1      ........................................................................................................................
P5_rs_rc2      ........................................................................................................................
P5_rs_rc3      ........................................................................................................................
P6_rs_rc4      ........................................................................................................................
P6_rs_rc5      ........................................................................................................................
P6_rs_rc6      ........................................................................................................................
P6_rs_rc7      ........................................................................................................................
P6_rs_rc8      ........................................................................................................................
P7_rs_us1      ........................................................................................................................
P7_rs_us2      ........................................................................................................................
P8_rs_pr4      ........................................................................................................................
P9_rs_pr5      ........................................................................................................................
P10_cn_jl1     ........................................................................................................................
P10_cn_jl2     ........................................................................................................................
P11_cn_jl3     ........................................................................................................................
P11_cn_jl4     ........................................................................................................................
P12_cn_sn1     ........................................................................................................................
P12_cn_sn2     ........................................................................................................................
P13_cn_mc1     ........................................................................................................................
P13_cn_mc2     ........................................................................................................................
P14_kr_hw1     ........................................................................................................................
P14_kr_hw2     ........................................................................................................................
P15_kr_dm1     ........................................................................................................................
P15_kr_dm2     ........................................................................................................................
P15_kr_dm3     ........................................................................................................................
P16_kr_sk1     ........................................................................................................................
P16_kr_sk2     ........................................................................................................................
P16_kr_sk3     ........................................................................................................................
P16_kr_sk4     ........................................................................................................................
P16_kr_sk5     ........................................................................................................................
P16_kr_sk6     ........................................................................................................................
P16_kr_sk7     ........................................................................................................................
P16_kr_sk8     ........................................................................................................................
P17_kr_sh1     ........................................................................................................................
P18_kr_gb1     ........................................................................................................................
P19_kr_gw1     ........................................................................................................................
P19_kr_gw2     ........................................................................................................................
P19_kr_gw3     ........................................................................................................................
P20_kr_ck1     ........................................................................................................................
P20_kr_ck2     ........................................................................................................................
P21_kr_hc1     ........................................................................................................................
P22_kr_hb1     ........................................................................................................................
P23_kr_hb2     ........................................................................................................................
P24_kr_mh1     ........................................................................................................................
P24_kr_mh2     ........................................................................................................................
p25_kr_tb1     ........................................................................................................................
p25_kr_tb2     ........................................................................................................................
P26_kr_tb3     ........................................................................................................................
P27_kr_so1     ........................................................................................................................
P27_kr_so2     ........................................................................................................................
P27_kr_so3     ........................................................................................................................
P27_kr_so4     ........................................................................................................................
P27_kr_so5     ........................................................................................................................
P27_kr_so6     ........................................................................................................................
P28_kr_il1     ........................................................................................................................
P29_kr_mj1     ........................................................................................................................
P29_kr_mj2     ........................................................................................................................
P30_kr_dk1     ........................................................................................................................
P31_kr_jr1     ........................................................................................................................
P32_kr_jr2     ........................................................................................................................
O1_jp_rb1      .....................................................................................................................T..
O2_jp_hk1      ........................................................................................................................
O2_jp_hk2      .....................................................................................................................T..
O2_jp_hk3      .....................................................................................................................T..
O2_jp_hk4      .....................................................................................................................T..
J1_jp_hn1      .....................................................................................................................T..
J1_jp_hn2      .....................................................................................................................T..
J2_jp_ky1      ........................................................................................................................
J3_jp_jp1      .....................................................................................................................T..
B1_cn_bj1      .........................................................................................................C..............
B2_uk_1        ........................................................................................................................
AMP_cn_1       G.......................................................................................................................
SUF_kr_hl1     G.........................................C.............................................................................
SUF_kr_hl2     G.........................................C.............................................................................
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Appendix 2. (Continued).

```
                                                                                                                                   2520
A1_kr_gr1      TAATGAAATAAATTTGTTAATTGGAACTGTATGCACTTTCTTATTATTTGCTGGTGCAGTTGCCAAATCCGCGCAATTCCCCCTTCATTTATGGTTACCTGATGCTATGGAGGGGCCTAC
A1_kr_gr2      .........C..............................................................................................................
A2_kr_hl1      ........................................................................................................................
A2_kr_hl2      ........................................................................................................................
A2_kr_hl3      .........C..............................................................................................................
A2_kr_hl4      ........................................................................................................................
A3_kr_hl5      .........C..............................................................................................................
A3_kr_hl6      .........C..............................................................................................................
A3_kr_hl7      ........................................................................................................................
A3_kr_hl8      ........................................................................................................................
A4_kr_hl9      ........................................................................................................................
A5_kr_hl10     .........C..............................................................................................................
A5_kr_hl11     .........C..............................................................................................................
A5_kr_hl12     .........C..............................................................................................................
A5_kr_hl13     .........C..............................................................................................................
A5_kr_hl14     .........C................................T.............................................................................
A7_mn_1        .........C..............................................................................................................
A8_mn_2        .........C..............................................................................................................
M1_rs_kb1      .........C..............................................................................................................
M2_rs_kh1      .........C..............................................................................................................
M2_rs_kh2      .........C..............................................................................................................
M2_rs_kh3      .........C..............................................................................................................
M3_rs_kh4      .........C..............................................................................................................
M3_rs_kh5      .........C..............................................................................................................
M3_rs_kh6      ..........................................................................................C.............................
M3_rs_kh7      ..........................................................................................C.............................
M3_rs_kh8      .........C..............................................................................................................
M3_rs_kh9      ..........................................................................................C.............................
M3_rs_kh10     ..........................................................................................C.............................
M3_rs_kh11     ..........................................................................................C.............................
M3_rs_kh12     ..........................................................................................C.............................
M3_rs_kh13     ..........................................................................................C.............................
M3_rs_kh14     ..........................................................................................C.............................
M3_rs_kh15     .........C..............................................................................................................
M3_rs_kh16     .........C..............................................................................................................
M3_rs_kh17     .........C..............................................................................................................
M3_rs_kh18     ..........................................................................................C.............................
M3_rs_kh19     .........C..............................................................................................................
M3_rs_kh20     ..........................................................................................C.............................
M3_rs_kh21     .........C..............................................................................................................
M3_rs_kh22     .........C..............................................................................................................
M3_rs_kh23     ..........................................................................................C.............................
M3_rs_kh24     .........C..............................................................................................................
M3_rs_kh25     .........C..............................................................................................................
M3_rs_kh26     ..........................................................................................C.............................
M3_rs_kh27     .........C..............................................................................................................
M3_rs_kh28     .........C..............................................................................................................
M3_rs_kh29     .........C..............................................................................................................
M3_rs_kh30     ..........................................................................................C.............................
M3_rs_kh31     .........C..............................................................................................................
M4_rs_kh32     .........C..............................................................................................................
M5_rs_ot1      ........................................................................................................................
M6_rs_ri1      ........................................................................................................................
M6_rs_ri2      .........C..............................................................................................................
M7_cn_hj1      ........................................................................................................................
M8_cn_hj2      .........C..............................................................................................................
M8_cn_hj3      .........C..............................................................................................................
M8_cn_hj4      .........C..............................................................................................................
M9_cn_hj5      .........C..............................................................................................................
M10_cn_nm1     .........C..............................................................................................................
M11_cn_ul1     .........C..............................................................................................................
M12_cn_sb1     .........C..............................................................................................................
M12_cn_sb2     .........C..............................................................................................................
M13_kr_od1     .........C..............................................................................................................
M14_kr_jm1     ..........................................................................................C.............................
M14_kr_jm2     ..........................................................................................C.............................
M14_kr_jm3     ..........................................................................................C.............................
M15_kr_dg1     ........................................................................................................................
M16_kr_dr1     .........C..............................................................................................................
M17_kr_sw1     ........................................................................................................................
M17_kr_sw2     ........................................................................................................................
M18_kr_hg1     .........C..............................................................................................................
M19_kr_gy1     .........C..............................................................................................................
M20_kr_nh1     ..........................................................................................C.............................
M20_kr_nh2     ..........................................................................................C.............................
M21_kr_gu1     .........C..............................................................................................................
M22_kr_mp1     .........C..............................................................................................................
M23_kr_bc1     .........C..............................................................................................................
M24_kr_os1     .........C..............................................................................................................
M25_kr_os2     .........C..............................................................................................................
M25_kr_os3     ........................................................................................................................
M25_kr_os4     .........C..............................................................................................................
M25_kr_os5     .........C..............................................................................................................
M26_kr_sn1     .........C..............................................................................................................
M27_kr_gn1     .........C................................T.............................................................................
M27_kr_gn2     .........C................................T.............................................................................
M28_kr_bs1     ........................................................................................................................
M28_kr_bs2     .........C........................G.....................................................................................
M28_kr_bs3     ........................................................................................................................
M29_kr_jn1     .........C..............................................................................................................
M30_kr_bl1     .........C..............................................................................................................
M30_kr_bl2     ........................................................................................................................
M31_kr_jl1     ........................................................................................................................
M31_kr_jl2     .........C..............................................................................................................
M32_kr_mt1     .........C..............................................................................................................
M33_kr_md1     .........C..............................................................................................................
M33_kr_md2     .........C..............................................................................................................
```

Appendix 2. (Continued).

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                                                                                                                                   2520
A1_kr_gr1      TAATGAAATAAATTTGTTAATTGGAACTGTATGCACTTTCTTATTATTTGCTGGTGCAGTTGCCAAATCCGCGCAATTCCCCCTTCATTTATGGTTACCTGATGCTATGGAGGGGCCTAC
M34_kr_dn1     .........C..............................................................................................................
M34_kr_dn2     .........C..............................................................................................................
M35_kr_sm1     .........C..............................................................................................................
M35_kr_sm2     .........C..............................................................................................................
P1_rs_ms1      .........C..............................................................................................................
P1_rs_ms2      .........C..............................................................................................................
P1_rs_ms3      .........C..............................................................................................................
P1_rs_ms4      .........C..............................................................................................................
P2_rs_nk1      .........C..............................................................................................................
P2_rs_nk2      .........C..............................................................................................................
P3_rs_pr1      .........C..............................................................................................................
P4_rs_pr2      .........C..............................................................................................................
P4_rs_pr3      ........................................................................................................................
P5_rs_rc1      ........................................................................................................................
P5_rs_rc2      .........C..............................................................................................................
P5_rs_rc3      .........C..............................................................................................................
P6_rs_rc4      ........................................................................................................................
P6_rs_rc5      ........................................................................................................................
P6_rs_rc6      ........................................................................................................................
P6_rs_rc7      ........................................................................................................................
P6_rs_rc8      .........C..............................................................................................................
P7_rs_us1      .........C..............................................................................................................
P7_rs_us2      .........C..............................................................................................................
P8_rs_pr4      .........C..............................................................................................................
P9_rs_pr5      ........................................................................................................................
P10_cn_jl1     .........C..............................................................................................................
P10_cn_jl2     .........C..............................................................................................................
P11_cn_jl3     .........C..............................................................................................................
P11_cn_jl4     .........C..............................................................................................................
P12_cn_sn1     .........C..............................................................................................................
P12_cn_sn2     .........C..............................................................................................................
P13_cn_mc1     .........C..............................................................................................................
P13_cn_mc2     .........C..............................................................................................................
P14_kr_hw1     .........C..............................................................................................................
P14_kr_hw2     .........C..............................................................................................................
P15_kr_dm1     ........................................................................................................................
P15_kr_dm2     ........................................................................................................................
P15_kr_dm3     ........................................................................................................................
P16_kr_sk1     .........C..............................................................................................................
P16_kr_sk2     .........C..............................................................................................................
P16_kr_sk3     .........C..............................................................................................................
P16_kr_sk4     .........C..............................................................................................................
P16_kr_sk5     .........C..............................................................................................................
P16_kr_sk6     .........C..............................................................................................................
P16_kr_sk7     .........C..............................................................................................................
P16_kr_sk8     .........C..............................................................................................................
P17_kr_sh1     ........................................................................................................................
P18_kr_gb1     .........C..............................................................................................................
P19_kr_gw1     .........C..............................................................................................................
P19_kr_gw2     .........C..............................................................................................................
P19_kr_gw3     .........C..............................................................................................................
P20_kr_ck1     .........C..............................................................................................................
P20_kr_ck2     .........C..............................................................................................................
P21_kr_hc1     .........C..............................................................................................................
P22_kr_hb1     .........C..............................................................................................................
P23_kr_hb2     .........C..............................................................................................................
P24_kr_mh1     .........C..............................................................................................................
P24_kr_mh2     .........C..............................................................................................................
p25_kr_tb1     .........C..............................................................................................................
p25_kr_tb2     .........C..............................................................................................................
P26_kr_tb3     .........C..............................................................................................................
P27_kr_so1     .........C..............................................................................................................
P27_kr_so2     .........C..............................................................................................................
P27_kr_so3     .........C..............................................................................................................
P27_kr_so4     .........C..............................................................................................................
P27_kr_so5     .........C..............................................................................................................
P27_kr_so6     .........C..............................................................................................................
P28_kr_il1     .........C..............................................................................................................
P29_kr_mj1     .........C..............................................................................................................
P29_kr_mj2     .........C..............................................................................................................
P30_kr_dk1     .........C..............................................................................................................
P31_kr_jr1     .........C..............................................................................................................
P32_kr_jr2     .........C..............................................................................................................
O1_jp_rb1      .........C..............................................................................................................
O2_jp_hk1      .........C..............................................................................................................
O2_jp_hk2      .........C..............................................................................................................
O2_jp_hk3      .........C..............................................................................................................
O2_jp_hk4      .........C..............................................................................................................
J1_jp_hn1      .........C..............................................................................................................
J1_jp_hn2      .........C..............................................................................................................
J2_jp_ky1      ..........................................................................................C.............................
J3_jp_jp1      .........C..............................................................................................................
B1_cn_bj1      ..........................................................................................C.............................
B2_uk_1        ........................................................................................................................
AMP_cn_1       ..........C.............................................................................G...............................
SUF_kr_hl1     ..........C.............................................................................G...............................
SUF_kr_hl2     ..........C.............................................................................G...............................
```

Appendix 2. (Continued).

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                                                                                                                                   2640
A1_kr_gr1      TCCTATTTCGGCTCTTATACATGCTGCTACTATGGTAGCAGCGGGTATTTTTCTTGTCGCTAGACTTTTTCCTCTTTTGGTAGTCATCCCCTCCATACTCAATCTAATCGCTTTAATAGG
A1_kr_gr2      ........................................................................................................................
A2_kr_hl1      ........................................................................................................................
A2_kr_hl2      ........................................................................................................................
A2_kr_hl3      ........................................................................................................................
A2_kr_hl4      ..............................................................................T.........................................
A3_kr_hl5      ........................................................................................................................
A3_kr_hl6      ........................................................................................................................
A3_kr_hl7      ..............................................................................T.........................................
A3_kr_hl8      ..............................................................................T.........................................
A4_kr_hl9      ........................................................................................................................
A5_kr_hl10     ........................................................................................................................
A5_kr_hl11     ........................................................................................................................
A5_kr_hl12     ........................................................................................................................
A5_kr_hl13     ........................................................................................................................
A5_kr_hl14     ........................................................................................................................
A7_mn_1        ........................................................................................................................
A8_mn_2        ........................................................................................................................
M1_rs_kb1      ........................................................................................................................
M2_rs_kh1      ........................................................................................................................
M2_rs_kh2      ........................................................................................................................
M2_rs_kh3      ........................................................................................................................
M3_rs_kh4      ........................................................................................................................
M3_rs_kh5      ........................................................................................................................
M3_rs_kh6      ........................................................................................................................
M3_rs_kh7      ........................................................................................................................
M3_rs_kh8      ........................................................................................................................
M3_rs_kh9      ........................................................................................................................
M3_rs_kh10     ........................................................................................................................
M3_rs_kh11     ........................................................................................................................
M3_rs_kh12     ........................................................................................................................
M3_rs_kh13     ........................................................................................................................
M3_rs_kh14     ........................................................................................................................
M3_rs_kh15     ........................................................................................................................
M3_rs_kh16     ........................................................................................................................
M3_rs_kh17     ........................................................................................................................
M3_rs_kh18     ........................................................................................................................
M3_rs_kh19     ........................................................................................................................
M3_rs_kh20     ........................................................................................................................
M3_rs_kh21     ........................................................................................................................
M3_rs_kh22     ........................................................................................................................
M3_rs_kh23     ........................................................................................................................
M3_rs_kh24     ........................................................................................................................
M3_rs_kh25     ........................................................................................................................
M3_rs_kh26     ........................................................................................................................
M3_rs_kh27     ........................................................................................................................
M3_rs_kh28     ........................................................................................................................
M3_rs_kh29     ........................................................................................................................
M3_rs_kh30     ........................................................................................................................
M3_rs_kh31     ........................................................................................................................
M4_rs_kh32     ........................................................................................................................
M5_rs_ot1      ........................................................................................................................
M6_rs_ri1      ................................................................................................................A.......
M6_rs_ri2      ........................................................................................................................
M7_cn_hj1      ........................................................................................................................
M8_cn_hj2      ........................................................................................................................
M8_cn_hj3      ........................................................................................................................
M8_cn_hj4      ........................................................................................................................
M9_cn_hj5      ........................................................................................................................
M10_cn_nm1     ........................................................................................................................
M11_cn_ul1     ........................................................................................................................
M12_cn_sb1     ........................................................................................................................
M12_cn_sb2     ........................................................................................................................
M13_kr_od1     ........................................................................................................................
M14_kr_jm1     ........................................................................................................................
M14_kr_jm2     ........................................................................................................................
M14_kr_jm3     ........................................................................................................................
M15_kr_dg1     ........................................................................................................................
M16_kr_dr1     ........................................................................................................................
M17_kr_sw1     ........................................................................................................................
M17_kr_sw2     ........................................................................................................................
M18_kr_hg1     ........................................................................................................................
M19_kr_gy1     ........................................................................................................................
M20_kr_nh1     ........................................................................................................................
M20_kr_nh2     ........................................................................................................................
M21_kr_gu1     ........................................................................................................................
M22_kr_mp1     ........................................................................................................................
M23_kr_bc1     ........................................................................................................................
M24_kr_os1     ........................................................................................................................
M25_kr_os2     ........................................................................................................................
M25_kr_os3     ................................................................................................................A.......
M25_kr_os4     ........................................................................................................................
M25_kr_os5     ........................................................................................................................
M26_kr_sn1     ........................................................................................................................
M27_kr_gn1     ........................................................................................................................
M27_kr_gn2     ........................................................................................................................
M28_kr_bs1     ........................................................................................................................
M28_kr_bs2     ........................................................................................................................
M28_kr_bs3     ........................................................................................................................
M29_kr_jn1     ........................................................................................................................
M30_kr_bl1     ........................................................................................................................
M30_kr_bl2     ........................................................................................................................
M31_kr_jl1     ........................................................................................................................
M31_kr_jl2     ........................................................................................................................
M32_kr_mt1     ........................................................................................................................
M33_kr_md1     ........................................................................................................................
M33_kr_md2     ........................................................................................................................
```

Appendix 2. (Continued).

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                                                                                                                                    2640
A1_kr_gr1       TCCTATTTCGGCTCTTATACATGCTGCTACTATGGTAGCAGCGGGTATTTTTCTTGTCGCTAGACTTTTTCCTCTTTTGGTAGTCATCCCCTCCATACTCAATCTAATCGCTTTAATAGG
M34_kr_dn1      ........................................................................................................................
M34_kr_dn2      ........................................................................................................................
M35_kr_sm1      ........................................................................................................................
M35_kr_sm2      ........................................................................................................................
P1_rs_ms1       ........................................................................................................................
P1_rs_ms2       ........................................................................................................................
P1_rs_ms3       ........................................................................................................................
P1_rs_ms4       ........................................................................................................................
P2_rs_nk1       ........................................................................................................................
P2_rs_nk2       ........................................................................................................................
P3_rs_pr1       ........................................................................................................................
P4_rs_pr2       ........................................................................................................................
P4_rs_pr3       ................................................................................................................A.......
P5_rs_rc1       ........................................................................................................................
P5_rs_rc2       ........................................................................................................................
P5_rs_rc3       ........................................................................................................................
P6_rs_rc4       ........................................................................................................................
P6_rs_rc5       ........................................................................................................................
P6_rs_rc6       ........................................................................................................................
P6_rs_rc7       ........................................................................................................................
P6_rs_rc8       ........................................................................................................................
P7_rs_us1       ........................................................................................................................
P7_rs_us2       ........................................................................................................................
P8_rs_pr4       ........................................................................................................................
P9_rs_pr5       ........................................................................................................................
P10_cn_jl1      ........................................................................................................................
P10_cn_jl2      ........................................................................................................................
P11_cn_jl3      ........................................................................................................................
P11_cn_jl4      ........................................................................................................................
P12_cn_sn1      ........................................................................................................................
P12_cn_sn2      ........................................................................................................................
P13_cn_mc1      ........................................................................................................................
P13_cn_mc2      ........................................................................................................................
P14_kr_hw1      ........................................................................................................................
P14_kr_hw2      ........................................................................................................................
P15_kr_dm1      ........................................................................................................................
P15_kr_dm2      ........................................................................................................................
P15_kr_dm3      ........................................................................................................................
P16_kr_sk1      ........................................................................................................................
P16_kr_sk2      ........................................................................................................................
P16_kr_sk3      ........................................................................................................................
P16_kr_sk4      ........................................................................................................................
P16_kr_sk5      ........................................................................................................................
P16_kr_sk6      ........................................................................................................................
P16_kr_sk7      ........................................................................................................................
P16_kr_sk8      ........................................................................................................................
P17_kr_sh1      ........................................................................................................................
P18_kr_gb1      ........................................................................................................................
P19_kr_gw1      ........................................................................................................................
P19_kr_gw2      ........................................................................................................................
P19_kr_gw3      ........................................................................................................................
P20_kr_ck1      ........................................................................................................................
P20_kr_ck2      ........................................................................................................................
P21_kr_hc1      ........................................................................................................................
P22_kr_hb1      ........................................................................................................................
P23_kr_hb2      ........................................................................................................................
P24_kr_mh1      ........................................................................................................................
P24_kr_mh2      ........................................................................................................................
p25_kr_tb1      ........................................................................................................................
p25_kr_tb2      ........................................................................................................................
P26_kr_tb3      ........................................................................................................................
P27_kr_so1      ........................................................................................................................
P27_kr_so2      ........................................................................................................................
P27_kr_so3      ........................................................................................................................
P27_kr_so4      ........................................................................................................................
P27_kr_so5      ........................................................................................................................
P27_kr_so6      ........................................................................................................................
P28_kr_il1      ........................................................................................................................
P29_kr_mj1      ........................................................................................................................
P29_kr_mj2      ........................................................................................................................
P30_kr_dk1      ........................................................................................................................
P31_kr_jr1      ........................................................................................................................
P32_kr_jr2      ........................................................................................................................
O1_jp_rb1       ........................................................................................................................
O2_jp_hk1       ........................................................................................................................
O2_jp_hk2       ........................................................................................................................
O2_jp_hk3       ........................................................................................................................
O2_jp_hk4       ........................................................................................................................
J1_jp_hn1       ........................................................................................................................
J1_jp_hn2       ........................................................................................................................
J2_jp_ky1       ........................................................................................................................
J3_jp_jp1       ........................................................................................................................
B1_cn_bj1       ........................................................................................................................
B2_uk_1         ........................................................................................................................
AMP_cn_1        ..............................C......................................C.........A........................................
SUF_kr_hl1      ...............................................................................A........................................
SUF_kr_hl2      ...............................................................................A........................................
```

Appendix 2. (Continued).

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                                                                                                                                  2760
A1_kr_gr1      TATAATAACAGTACTTTTAGGGGCTACTTTAGCTCTTGCTCAAAAAGACATTAAGAGAAGTTTAGCTTATTCTACAATGTCTCAATTGGGGTATATGATGTTAGCTCTAGGTATGGGGTC
A1_kr_gr2      ........................................................................................................................
A2_kr_hl1      ........................................................................................................................
A2_kr_hl2      ........................................................................................................................
A2_kr_hl3      ........................................................................................................................
A2_kr_hl4      ........................................................................................................................
A3_kr_hl5      ........................................................................................................................
A3_kr_hl6      ........................................................................................................................
A3_kr_hl7      ........................................................................................................................
A3_kr_hl8      ........................................................................................................................
A4_kr_hl9      ........................................................................................................................
A5_kr_hl10     ........................................................................................................................
A5_kr_hl11     ........................................................................................................................
A5_kr_hl12     ........................................................................................................................
A5_kr_hl13     ........................................................................................................................
A5_kr_hl14     ........................................................................................................................
A7_mn_1        ........................................................................................................................
A8_mn_2        ........................................................................................................................
M1_rs_kb1      ........................................................................................................................
M2_rs_kh1      ........................................................................................................................
M2_rs_kh2      ........................................................................................................................
M2_rs_kh3      ........................................................................................................................
M3_rs_kh4      ........................................................................................................................
M3_rs_kh5      ........................................................................................................................
M3_rs_kh6      ........................................................................................................................
M3_rs_kh7      ........................................................................................................................
M3_rs_kh8      ........................................................................................................................
M3_rs_kh9      ........................................................................................................................
M3_rs_kh10     ........................................................................................................................
M3_rs_kh11     ........................................................................................................................
M3_rs_kh12     ........................................................................................................................
M3_rs_kh13     ........................................................................................................................
M3_rs_kh14     ........................................................................................................................
M3_rs_kh15     ........................................................................................................................
M3_rs_kh16     ........................................................................................................................
M3_rs_kh17     ........................................................................................................................
M3_rs_kh18     ........................................................................................................................
M3_rs_kh19     ........................................................................................................................
M3_rs_kh20     ........................................................................................................................
M3_rs_kh21     ........................................................................................................................
M3_rs_kh22     ........................................................................................................................
M3_rs_kh23     ........................................................................................................................
M3_rs_kh24     ........................................................................................................................
M3_rs_kh25     ........................................................................................................................
M3_rs_kh26     ........................................................................................................................
M3_rs_kh27     ........................................................................................................................
M3_rs_kh28     ........................................................................................................................
M3_rs_kh29     ........................................................................................................................
M3_rs_kh30     ........................................................................................................................
M3_rs_kh31     ........................................................................................................................
M4_rs_kh32     ........................................................................................................................
M5_rs_ot1      ........................................................................................................................
M6_rs_ri1      ........................................................................................................................
M6_rs_ri2      ........................................................................................................................
M7_cn_hj1      ........................................................................................................................
M8_cn_hj2      ........................................................................................................................
M8_cn_hj3      ........................................................................................................................
M8_cn_hj4      ........................................................................................................................
M9_cn_hj5      ............C...........................................................................................................
M10_cn_nm1     ........................................................................................................................
M11_cn_ul1     ........................................................................................................................
M12_cn_sb1     ........................................................................................................................
M12_cn_sb2     ........................................................................................................................
M13_kr_od1     ........................................................................................................................
M14_kr_jm1     ........................................................................................................................
M14_kr_jm2     ........................................................................................................................
M14_kr_jm3     ........................................................................................................................
M15_kr_dg1     ........................................................................................................................
M16_kr_dr1     ........................................................................................................................
M17_kr_sw1     ........................................................................................................................
M17_kr_sw2     ........................................................................................................................
M18_kr_hg1     ........................................................................................................................
M19_kr_gy1     ........................................................................................................................
M20_kr_nh1     ........................................................................................................................
M20_kr_nh2     ........................................................................................................................
M21_kr_gu1     ........................................................................................................................
M22_kr_mp1     ........................................................................................................................
M23_kr_bc1     ........................................................................................................................
M24_kr_os1     ........................................................................................................................
M25_kr_os2     ........................................................................................................................
M25_kr_os3     ........................................................................................................................
M25_kr_os4     ........................................................................................................................
M25_kr_os5     ........................................................................................................................
M26_kr_sn1     ........................................................................................................................
M27_kr_gn1     ........................................................................................................................
M27_kr_gn2     ........................................................................................................................
M28_kr_bs1     ........................................................................................................................
M28_kr_bs2     ........................................................................................................................
M28_kr_bs3     ........................................................................................................................
M29_kr_jn1     ........................................................................................................................
M30_kr_bl1     ........................................................................................................................
M30_kr_bl2     ........................................................................................................................
M31_kr_jl1     ........................................................................................................................
M31_kr_jl2     ........................................................................................................................
M32_kr_mt1     ........................................................................................................................
M33_kr_md1     ........................................................................................................................
M33_kr_md2     ........................................................................................................................
```

Appendix 2. (Continued).

```
                                                                                                                                  2760
A1_kr_gr1      TATAATAACAGTACTTTTAGGGGCTACTTTAGCTCTTGCTCAAAAAGACATTAAGAGAAGTTTAGCTTATTCTACAATGTCTCAATTGGGGTATATGATGTTAGCTCTAGGTATGGGGTC
M34_kr_dn1     ........................................................................................................................
M34_kr_dn2     ........................................................................................................................
P1_rs_ms1      ........................................................................................................................
P1_rs_ms2      ........................................................................................................................
P1_rs_ms3      ........................................................................................................................
P1_rs_ms4      ........................................................................................................................
P2_rs_nk1      ........................................................................................................................
P2_rs_nk2      ........................................................................................................................
P3_rs_pr1      ........................................................................................................................
P4_rs_pr2      ........................................................................................................................
P4_rs_pr3      ........................................................................................................................
P5_rs_rc1      ........................................................................................................................
P5_rs_rc2      ........................................................................................................................
P5_rs_rc3      ........................................................................................................................
P6_rs_rc4      ........................................................................................................................
P6_rs_rc5      ........................................................................................................................
P6_rs_rc6      ........................................................................................................................
P6_rs_rc7      ........................................................................................................................
P6_rs_rc8      ........................................................................................................................
P7_rs_us1      ........................................................................................................................
P7_rs_us2      ........................................................................................................................
P8_rs_pr4      ........................................................................................................................
P9_rs_pr5      ........................................................................................................................
P10_cn_jl1     ........................................................................................................................
P10_cn_jl2     ........................................................................................................................
P11_cn_jl3     ........................................................................................................................
P11_cn_jl4     ........................................................................................................................
P12_cn_sn1     ........................................................................................................................
P12_cn_sn2     ........................................................................................................................
P13_cn_mc1     ........................................................................................................................
P13_cn_mc2     ........................................................................................................................
P14_kr_hw1     ........................................................................................................................
P14_kr_hw2     ........................................................................................................................
P15_kr_dm1     ........................................................................................................................
P15_kr_dm2     ........................................................................................................................
P15_kr_dm3     ........................................................................................................................
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P16_kr_sk2     ........................................................................................................................
P16_kr_sk3     ........................................................................................................................
P16_kr_sk4     ........................................................................................................................
P16_kr_sk5     ........................................................................................................................
P16_kr_sk6     ........................................................................................................................
P16_kr_sk7     ........................................................................................................................
P16_kr_sk8     ........................................................................................................................
P17_kr_sh1     ........................................................................................................................
P18_kr_gb1     ........................................................................................................................
P19_kr_gw1     ........................................................................................................................
P19_kr_gw2     ........................................................................................................................
P19_kr_gw3     ........................................................................................................................
P20_kr_ck1     ........................................................................................................................
P20_kr_ck2     ........................................................................................................................
P21_kr_hc1     ........................................................................................................................
P22_kr_hb1     ........................................................................................................................
P23_kr_hb2     ........................................................................................................................
P24_kr_mh1     ........................................................................................................................
P24_kr_mh2     ........................................................................................................................
p25_kr_tb1     ........................................................................................................................
p25_kr_tb2     ........................................................................................................................
P26_kr_tb3     ........................................................................................................................
P27_kr_so1     ........................................................................................................................
P27_kr_so2     ........................................................................................................................
P27_kr_so3     ........................................................................................................................
P27_kr_so4     ........................................................................................................................
P27_kr_so5     ........................................................................................................................
P27_kr_so6     ........................................................................................................................
P28_kr_il1     ........................................................................................................................
P29_kr_mj1     ........................................................................................................................
P29_kr_mj2     ........................................................................................................................
P30_kr_dk1     ........................................................................................................................
P31_kr_jr1     ........................................................................................................................
P32_kr_jr2     ........................................................................................................................
O1_jp_rb1      ........................................................................................................................
O2_jp_hk1      ........................................................................................................................
O2_jp_hk2      ........................................................................................................................
O2_jp_hk3      ........................................................................................................................
O2_jp_hk4      ........................................................................................................................
J1_jp_hn1      ........................................................................................................................
J1_jp_hn2      ........................................................................................................................
J2_jp_ky1      ........................................................................................................................
J3_jp_jp1      ........................................................................................................................
B1_cn_bj1      ........................................................................................................................
B2_uk_1        ........................................................................................................................
AMP_cn_1       ........................................................................................................................
SUF_kr_hl1     ........................................................................................................................
SUF_kr_hl2     ........................................................................................................................
```

Appendix 2. (Continued).

```
                                                                                                                                    2880
A1_kr_gr1       TTATCAAGCTGCTTTATTTCATTTGATTACTCATGCTTACTCAAAAGCATTATTGTTTTTAGGATCTGGATCTATTATTCATTCTATGGAAGCTATTGTTGGGTATTCTCCAGAGAAAAG
A1_kr_gr2       ........................................................................................................................
A2_kr_hl1       ........................................................................................................................
A2_kr_hl2       ........................................................................................................................
A2_kr_hl3       ........................................................................................................................
A2_kr_hl4       ........................................................................................................................
A3_kr_hl5       ........................................................................................................................
A3_kr_hl6       ........................................................................................................................
A3_kr_hl7       ........................................................................................................................
A3_kr_hl8       ........................................................................................................................
A4_kr_hl9       ........................................................................................................................
A5_kr_hl10      ........................................................................................................................
A5_kr_hl11      ........................................................................................................................
A5_kr_hl12      ........................................................................................................................
A5_kr_hl13      ........................................................................................................................
A5_kr_hl14      ........................................................................................................................
A7_mn_1         ........................................................................................................................
A8_mn_2         ........................................................................................................................
M1_rs_kb1       ........................................................................................................................
M2_rs_kh1       ........................................................................................................................
M2_rs_kh2       ........................................................................................................................
M2_rs_kh3       ........................................................................................................................
M3_rs_kh4       ........................................................................................................................
M3_rs_kh5       ........................................................................................................................
M3_rs_kh6       ........................................................................................................................
M3_rs_kh7       ........................................................................................................................
M3_rs_kh8       ........................................................................................................................
M3_rs_kh9       ........................................................................................................................
M3_rs_kh10      ........................................................................................................................
M3_rs_kh11      ........................................................................................................................
M3_rs_kh12      ........................................................................................................................
M3_rs_kh13      ........................................................................................................................
M3_rs_kh14      ........................................................................................................................
M3_rs_kh15      ........................................................................................................................
M3_rs_kh16      ........................................................................................................................
M3_rs_kh17      ........................................................................................................................
M3_rs_kh18      ........................................................................................................................
M3_rs_kh19      ........................................................................................................................
M3_rs_kh20      ........................................................................................................................
M3_rs_kh21      ........................................................................................................................
M3_rs_kh22      ........................................................................................................................
M3_rs_kh23      ........................................................................................................................
M3_rs_kh24      ........................................................................................................................
M3_rs_kh25      ........................................................................................................................
M3_rs_kh26      ........................................................................................................................
M3_rs_kh27      ........................................................................................................................
M3_rs_kh28      ........................................................................................................................
M3_rs_kh29      ........................................................................................................................
M3_rs_kh30      ........................................................................................................................
M3_rs_kh31      ........................................................................................................................
M4_rs_kh32      ........................................................................................................................
M5_rs_ot1       ........................................................................................................................
M6_rs_ri1       ........................................................................................................................
M6_rs_ri2       ........................................................................................................................
M7_cn_hj1       ........................................................................................................................
M8_cn_hj2       ........................................................................................................................
M8_cn_hj3       ...................................................................................T....................................
M8_cn_hj4       ...................................................................................T....................................
M9_cn_hj5       ...................................................................................T....................................
M10_cn_nm1      ........................................................................................................................
M11_cn_ul1      ...................................................................................T....................................
M12_cn_sb1      ...................................................................................T....................................
M12_cn_sb2      ...................................................................................T....................................
M13_kr_od1      ........................................................................................................................
M14_kr_jm1      ........................................................................................................................
M14_kr_jm2      ........................................................................................................................
M14_kr_jm3      ........................................................................................................................
M15_kr_dg1      ........................................................................................................................
M16_kr_dr1      ........................................................................................................................
M17_kr_sw1      ........................................................................................................................
M17_kr_sw2      ........................................................................................................................
M18_kr_hg1      ........................................................................................................................
M19_kr_gy1      ........................................................................................................................
M20_kr_nh1      ........................................................................................................................
M20_kr_nh2      ........................................................................................................................
M21_kr_gu1      ........................................................................................................................
M22_kr_mp1      ........................................................................................................................
M23_kr_bc1      ........................................................................................................................
M24_kr_os1      ........................................................................................................................
M25_kr_os2      ........................................................................................................................
M25_kr_os3      ........................................................................................................................
M25_kr_os4      ........................................................................................................................
M25_kr_os5      ........................................................................................................................
M26_kr_sn1      ........................................................................................................................
M27_kr_gn1      ........................................................................................................................
M27_kr_gn2      ........................................................................................................................
M28_kr_bs1      ........................................................................................................................
M28_kr_bs2      ........................................................................................................................
M28_kr_bs3      ........................................................................................................................
M29_kr_jn1      ........................................................................................................................
M30_kr_bl1      ........................................................................................................................
M30_kr_bl2      ........................................................................................................................
M31_kr_jl1      ........................................................................................................................
M31_kr_jl2      ........................................................................................................................
M32_kr_mt1      ........................................................................................................................
M33_kr_md1      ........................................................................................................................
M33_kr_md2      ........................................................................................................................
```

Appendix 2. (Continued).

```
                                                                                                                                    2880
A1_kr_gr1       TTATCAAGCTGCTTTATTTCATTTGATTACTCATGCTTACTCAAAAGCATTATTGTTTTTAGGATCTGGATCTATTATTCATTCTATGGAAGCTATTGTTGGGTATTCTCCAGAGAAAAG
M34_kr_dn1      ........................................................................................................................
M34_kr_dn2      ........................................................................................................................
M35_kr_sm1      ........................................................................................................................
M35_kr_sm2      ........................................................................................................................
P1_rs_ms1       ........................................................................................................................
P1_rs_ms2       ........................................................................................................................
P1_rs_ms3       ........................................................................................................................
P1_rs_ms4       ........................................................................................................................
P2_rs_nk1       ........................................................................................................................
P2_rs_nk2       ........................................................................................................................
P3_rs_pr1       ........................................................................................................................
P4_rs_pr2       ........................................................................................................................
P4_rs_pr3       ........................................................................................................................
P5_rs_rc1       ........................................................................................................................
P5_rs_rc2       ........................................................................................................................
P5_rs_rc3       ........................................................................................................................
P6_rs_rc4       ........................................................................................................................
P6_rs_rc5       ........................................................................................................................
P6_rs_rc6       ........................................................................................................................
P6_rs_rc7       ........................................................................................................................
P6_rs_rc8       ........................................................................................................................
P7_rs_us1       ........................................................................................................................
P7_rs_us2       ........................................................................................................................
P8_rs_pr4       ........................................................................................................................
P9_rs_pr5       ........................................................................................................................
P10_cn_jl1      ...................................................................................T....................................
P10_cn_jl2      ...................................................................................T....................................
P11_cn_jl3      ...................................................................................T....................................
P11_cn_jl4      ...................................................................................T....................................
P12_cn_sn1      ...................................................................................T....................................
P12_cn_sn2      ...................................................................................T....................................
P13_cn_mc1      ...................................................................................T....................................
P13_cn_mc2      ...................................................................................T....................................
P14_kr_hw1      ........................................................................................................................
P14_kr_hw2      ........................................................................................................................
P15_kr_dm1      ........................................................................................................................
P15_kr_dm2      ........................................................................................................................
P15_kr_dm3      ........................................................................................................................
P16_kr_sk1      ...................................................................................T....................................
P16_kr_sk2      ...................................................................................T....................................
P16_kr_sk3      ...................................................................................T....................................
P16_kr_sk4      ...................................................................................T....................................
P16_kr_sk5      ........................................................................................................................
P16_kr_sk6      ...................................................................................T....................................
P16_kr_sk7      ...................................................................................T....................................
P16_kr_sk8      ...................................................................................T....................................
P17_kr_sh1      ........................................................................................................................
P18_kr_gb1      ........................................................................................................................
P19_kr_gw1      ........................................................................................................................
P19_kr_gw2      ........................................................................................................................
P19_kr_gw3      ........................................................................................................................
P20_kr_ck1      ........................................................................................................................
P20_kr_ck2      ........................................................................................................................
P21_kr_hc1      ........................................................................................................................
P22_kr_hb1      ........................................................................................................................
P23_kr_hb2      ........................................................................................................................
P24_kr_mh1      ................................................................................C.......................................
P24_kr_mh2      ........................................................................................................................
p25_kr_tb1      ........................................................................................................................
p25_kr_tb2      ........................................................................................................................
P26_kr_tb3      ........................................................................................................................
P27_kr_so1      ........................................................................................................................
P27_kr_so2      ........................................................................................................................
P27_kr_so3      ........................................................................................................................
P27_kr_so4      ........................................................................................................................
P27_kr_so5      ........................................................................................................................
P27_kr_so6      ........................................................................................................................
P28_kr_il1      ........................................................................................................................
P29_kr_mj1      ........................................................................................................................
P29_kr_mj2      ........................................................................................................................
P30_kr_dk1      ........................................................................................................................
P31_kr_jr1      ........................................................................................................................
O1_jp_rb1       ........................................................................................................................
O2_jp_hk1       ........................................................................................................................
O2_jp_hk2       ........................................................................................................................
O2_jp_hk3       ........................................................................................................................
O2_jp_hk4       ........................................................................................................................
J1_jp_hn1       ........................................................................................................................
J1_jp_hn2       ........................................................................................................................
J2_jp_ky1       ........................................................................................................................
J3_jp_jp1       ........................................................................................................................
B1_cn_bj1       ........................................................................................................................
B2_uk_1         ........................................................................................................................
AMP_cn_1        ........................................................................................................................
SUF_kr_hl1      ........................................................................................................................
SUF_kr_hl2      ........................................................................................................................
```

Appendix 2. (Continued).

```
                                                                                                                                   3000
A1_kr_gr1      CCAGAATATGGTTTTTATGGGGGGGTTAAAAAAGCACGCGCCAATTACAAAAACTGCTTTTTTTTTAGGTACACTTTCTCTTTCTGGTATTCCGCCTCTTGCTTGTTTTTGGTCCAAAGA
A1_kr_gr2      ........................................................................................................................
A2_kr_hl1      ........................................................................................................................
A2_kr_hl2      ........................................................................................................................
A2_kr_hl3      ........................................................................................................................
A2_kr_hl4      ........................................................................................................................
A3_kr_hl5      ........................................................................................................................
A3_kr_hl6      ........................................................................................................................
A3_kr_hl7      ........................................................................................................................
A3_kr_hl8      ........................................................................................................................
A4_kr_hl9      ........................................................................................................................
A5_kr_hl10     ........................................................................................................................
A5_kr_hl11     ........................................................................................................................
A5_kr_hl12     ........................................................................................................................
A5_kr_hl13     ........................................................................................................................
A5_kr_hl14     ........................................................................................................................
A7_mn_1        ........................................................................................................................
A8_mn_2        ........................................................................................................................
M1_rs_kb1      ........................................................................................................................
M2_rs_kh1      ........................................................................................................................
M2_rs_kh2      ........................................................................................................................
M2_rs_kh3      ........................................................................................................................
M3_rs_kh4      ........................................................................................................................
M3_rs_kh5      ........................................................................................................................
M3_rs_kh6      ........................................................................................................................
M3_rs_kh7      ........................................................................................................................
M3_rs_kh8      ........................................................................................................................
M3_rs_kh9      ........................................................................................................................
M3_rs_kh10     ........................................................................................................................
M3_rs_kh11     ........................................................................................................................
M3_rs_kh12     ........................................................................................................................
M3_rs_kh13     ........................................................................................................................
M3_rs_kh14     ........................................................................................................................
M3_rs_kh15     ........................................................................................................................
M3_rs_kh16     ........................................................................................................................
M3_rs_kh17     ........................................................................................................................
M3_rs_kh18     ........................................................................................................................
M3_rs_kh19     ........................................................................................................................
M3_rs_kh20     ........................................................................................................................
M3_rs_kh21     ........................................................................................................................
M3_rs_kh22     ........................................................................................................................
M3_rs_kh23     ........................................................................................................................
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M3_rs_kh25     ........................................................................................................................
M3_rs_kh26     ........................................................................................................................
M3_rs_kh27     ........................................................................................................................
M3_rs_kh28     ........................................................................................................................
M3_rs_kh29     ........................................................................................................................
M3_rs_kh30     ........................................................................................................................
M3_rs_kh31     ........................................................................................................................
M4_rs_kh32     ........................................................................................................................
M5_rs_ot1      ........................................................................................................................
M6_rs_ri1      ........................................................................................................................
M6_rs_ri2      ........................................................................................................................
M7_cn_hj1      ........................................................................................................................
M8_cn_hj2      ........................................................................................................................
M8_cn_hj3      ........................................................................................................................
M8_cn_hj4      ........................................................................................................................
M9_cn_hj5      ........................................................................................................................
M10_cn_nm1     ........................................................................................................................
M11_cn_ul1     ........................................................................................................................
M12_cn_sb1     ........................................................................................................................
M12_cn_sb2     ........................................................................................................................
M13_kr_od1     ........................................................................................................................
M14_kr_jm1     ........................................................................................................................
M14_kr_jm2     ........................................................................................................................
M14_kr_jm3     ........................................................................................................................
M15_kr_dg1     ........................................................................................................................
M16_kr_dr1     ........................................................................................................................
M17_kr_sw1     ........................................................................................................................
M17_kr_sw2     ........................................................................................................................
M18_kr_hg1     ........................................................................................................................
M19_kr_gy1     ........................................................................................................................
M20_kr_nh1     ........................................................................................................................
M20_kr_nh2     ........................................................................................................................
M21_kr_gu1     ........................................................................................................................
M22_kr_mp1     ........................................................................................................................
M23_kr_bc1     ........................................................................................................................
M24_kr_os1     ........................................................................................................................
M25_kr_os2     ........................................................................................................................
M25_kr_os3     ........................................................................................................................
M25_kr_os4     ........................................................................................................................
M25_kr_os5     ........................................................................................................................
M26_kr_sn1     ........................................................................................................................
M27_kr_gn1     ........................................................................................................................
M27_kr_gn2     ........................................................................................................................
M28_kr_bs1     ........................................................................................................................
M28_kr_bs2     ........................................................................................................................
M28_kr_bs3     ........................................................................................................................
M29_kr_jn1     ........................................................................................................................
M30_kr_bl1     ........................................................................................................................
M30_kr_bl2     ........................................................................................................................
M31_kr_jl1     ........................................................................................................................
M31_kr_jl2     ........................................................................................................................
M32_kr_mt1     ........................................................................................................................
M33_kr_md1     ........................................................................................................................
M33_kr_md2     ........................................................................................................................
```

Appendix 2. (Continued).

```
                                                                                                                                   3000
A1_kr_gr1      CCAGAATATGGTTTTTATGGGGGGGTTAAAAAAGCACGCGCCAATTACAAAAACTGCTTTTTTTTTAGGTACACTTTCTCTTTCTGGTATTCCGCCTCTTGCTTGTTTTTGGTCCAAAGA
M34_kr_dn1     ........................................................................................................................
M34_kr_dn2     ........................................................................................................................
M35_kr_sm1     ........................................................................................................................
M35_kr_sm2     ........................................................................................................................
P1_rs_ms1      ........................................................................................................................
P1_rs_ms2      ........................................................................................................................
P1_rs_ms3      ........................................................................................................................
P1_rs_ms4      ........................................................................................................................
P2_rs_nk1      ........................................................................................................................
P2_rs_nk2      ........................................................................................................................
P3_rs_pr1      ........................................................................................................................
P4_rs_pr2      ........................................................................................................................
P4_rs_pr3      ........................................................................................................................
P5_rs_rc1      ........................................................................................................................
P5_rs_rc2      ........................................................................................................................
P5_rs_rc3      ........................................................................................................................
P6_rs_rc4      ........................................................................................................................
P6_rs_rc5      ........................................................................................................................
P6_rs_rc6      ........................................................................................................................
P6_rs_rc7      ........................................................................................................................
P6_rs_rc8      ........................................................................................................................
P7_rs_us1      ........................................................................................................................
P7_rs_us2      ........................................................................................................................
P8_rs_pr4      ........................................................................................................................
P9_rs_pr5      ........................................................................................................................
P10_cn_jl1     ........................................................................................................................
P10_cn_jl2     ........................................................................................................................
P11_cn_jl3     ........................................................................................................................
P11_cn_jl4     ........................................................................................................................
P12_cn_sn1     ........................................................................................................................
P12_cn_sn2     ........................................................................................................................
P13_cn_mc1     ........................................................................................................................
P13_cn_mc2     ........................................................................................................................
P14_kr_hw1     ........................................................................................................................
P14_kr_hw2     ........................................................................................................................
P15_kr_dm1     ........................................................................................................................
P15_kr_dm2     ........................................................................................................................
P15_kr_dm3     ........................................................................................................................
P16_kr_sk1     ........................................................................................................................
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P16_kr_sk3     ........................................................................................................................
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P16_kr_sk7     ........................................................................................................................
P16_kr_sk8     ........................................................................................................................
P17_kr_sh1     ........................................................................................................................
P18_kr_gb1     ........................................................................................................................
P19_kr_gw1     ........................................................................................................................
P19_kr_gw2     ........................................................................................................................
P19_kr_gw3     ........................................................................................................................
P20_kr_ck1     ........................................................................................................................
P20_kr_ck2     ........................................................................................................................
P21_kr_hc1     ........................................................................................................................
P22_kr_hb1     ........................................................................................................................
P23_kr_hb2     ........................................................................................................................
P24_kr_mh1     ........................................................................................................................
P24_kr_mh2     ........................................................................................................................
p25_kr_tb1     ........................................................................................................................
p25_kr_tb2     ........................................................................................................................
P26_kr_tb3     ........................................................................................................................
P27_kr_so1     ........................................................................................................................
P27_kr_so2     ........................................................................................................................
P27_kr_so3     ........................................................................................................................
P27_kr_so4     ........................................................................................................................
P27_kr_so5     ........................................................................................................................
P27_kr_so6     ........................................................................................................................
P28_kr_il1     ........................................................................................................................
P29_kr_mj1     ........................................................................................................................
P29_kr_mj2     ........................................................................................................................
P30_kr_dk1     ........................................................................................................................
P31_kr_jr1     ........................................................................................................................
O1_jp_rb1      ........................................................................................................................
O2_jp_hk1      ........................................................................................................................
O2_jp_hk2      ........................................................................................................................
O2_jp_hk3      ........................................................................................................................
O2_jp_hk4      ........................................................................................................................
J1_jp_hn1      ........................................................................................................................
J1_jp_hn2      ........................................................................................................................
J2_jp_ky1      ........................................................................................................................
J3_jp_jp1      ........................................................................................................................
B1_cn_bj1      ........................................................................................................................
B2_uk_1        ........................................................................................................................
AMP_cn_1       ........................................................................................................................
SUF_kr_hl1     ......................................................................................................G.................
SUF_kr_hl2     ......................................................................................................G.................
```

Appendix 2. (Continued).

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                                                                                                                                  3120
A1_kr_gr1      TGAAATTCTTAATGATAGTTGGTTGTATTCACCAATTTTCGCAAGCATATCCTGGGCTACAGCAGCATTAACTGCATTTTATATGTTTCGCATCTATTTACTTACGTTTGAGGGTCATTT
A1_kr_gr2      ........................................................................................................................
A2_kr_hl1      ........................................................................................................................
A2_kr_hl2      ........................................................................................................................
A2_kr_hl3      ........................................................................................................................
A2_kr_hl4      ........................................................................................................................
A3_kr_hl5      ........................................................................................................................
A3_kr_hl6      ........................................................................................................................
A3_kr_hl7      ........................................................................................................................
A3_kr_hl8      ........................................................................................................................
A4_kr_hl9      ........................................................................................................................
A5_kr_hl10     ........................................................................................................................
A5_kr_hl11     ........................................................................................................................
A5_kr_hl12     ........................................................................................................................
A5_kr_hl13     ........................................................................................................................
A5_kr_hl14     ........................................................................................................................
A7_mn_1        ........................................................................................................................
A8_mn_2        ........................................................................................................................
M1_rs_kb1      ........................................................................................................................
M2_rs_kh1      ........................................................................................................................
M2_rs_kh2      ........................................................................................................................
M2_rs_kh3      ........................................................................................................................
M3_rs_kh4      ........................................................................................................................
M3_rs_kh5      ........................................................................................................................
M3_rs_kh6      ........................................................................................................................
M3_rs_kh7      ........................................................................................................................
M3_rs_kh8      ........................................................................................................................
M3_rs_kh9      ........................................................................................................................
M3_rs_kh10     ........................................................................................................................
M3_rs_kh11     ........................................................................................................................
M3_rs_kh12     ........................................................................................................................
M3_rs_kh13     ........................................................................................................................
M3_rs_kh14     ........................................................................................................................
M3_rs_kh15     ........................................................................................................................
M3_rs_kh16     ........................................................................................................................
M3_rs_kh17     ........................................................................................................................
M3_rs_kh18     ........................................................................................................................
M3_rs_kh19     ........................................................................................................................
M3_rs_kh20     ........................................................................................................................
M3_rs_kh21     ........................................................................................................................
M3_rs_kh22     ........................................................................................................................
M3_rs_kh23     ........................................................................................................................
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M3_rs_kh25     ........................................................................................................................
M3_rs_kh26     ........................................................................................................................
M3_rs_kh27     ........................................................................................................................
M3_rs_kh28     ........................................................................................................................
M3_rs_kh29     ........................................................................................................................
M3_rs_kh30     ........................................................................................................................
M3_rs_kh31     ........................................................................................................................
M4_rs_kh32     ........................................................................................................................
M5_rs_ot1      ........................................................................................................................
M6_rs_ri1      ..............................................................T.........................................................
M6_rs_ri2      ........................................................................................................................
M7_cn_hj1      ........................................................................................................................
M8_cn_hj3      ........................................................................................................................
M8_cn_hj2      .........................................................................................................A..............
M8_cn_hj4      ........................................................................................................................
M9_cn_hj5      ........................................................................................................................
M10_cn_nm1     ........................................................................................................................
M11_cn_ul1     ........................................................................................................................
M12_cn_sb1     ........................................................................................................................
M12_cn_sb2     ........................................................................................................................
M13_kr_od1     ........................................................................................................................
M14_kr_jm1     ........................................................................................................................
M14_kr_jm2     ........................................................................................................................
M14_kr_jm3     ........................................................................................................................
M15_kr_dg1     ........................................................................................................................
M16_kr_dr1     ........................................................................................................................
M17_kr_sw1     ........................................................................................................................
M17_kr_sw2     ........................................................................................................................
M18_kr_hg1     ........................................................................................................................
M19_kr_gy1     ........................................................................................................................
M20_kr_nh1     ........................................................................................................................
M20_kr_nh2     ........................................................................................................................
M21_kr_gu1     ........................................................................................................................
M22_kr_mp1     ........................................................................................................................
M23_kr_bc1     ........................................................................................................................
M24_kr_os1     ........................................................................................................................
M25_kr_os2     ........................................................................................................................
M25_kr_os3     ..............................................................T.........................................................
M25_kr_os4     ........................................................................................................................
M25_kr_os5     ........................................................................................................................
M26_kr_sn1     ........................................................................................................................
M27_kr_gn1     ........................................................................................................................
M27_kr_gn2     ........................................................................................................................
M28_kr_bs1     ........................................................................................................................
M28_kr_bs2     ........................................................................................................................
M28_kr_bs3     ........................................................................................................................
M29_kr_jn1     ........................................................................................................................
M30_kr_bl1     ........................................................................................................................
M30_kr_bl2     ........................................................................................................................
M31_kr_jl1     ........................................................................................................................
M31_kr_jl2     ........................................................................................................................
M32_kr_mt1     ........................................................................................................................
M33_kr_md1     ........................................................................................................................
M33_kr_md2     ........................................................................................................................
```

Appendix 2. (Continued).

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                                                                                                                                   3120
A1_kr_gr1      TGAAATTCTTAATGATAGTTGGTTGTATTCACCAATTTTCGCAAGCATATCCTGGGCTACAGCAGCATTAACTGCATTTTATATGTTTCGCATCTATTTACTTACGTTTGAGGGTCATTT
M34_kr_dn1     ........................................................................................................................
M34_kr_dn2     ........................................................................................................................
M35_kr_sm1     ........................................................................................................................
M35_kr_sm2     ........................................................................................................................
P1_rs_ms1      ........................................................................................................................
P1_rs_ms2      ........................................................................................................................
P1_rs_ms3      ........................................................................................................................
P1_rs_ms4      ........................................................................................................................
P2_rs_nk1      .......................................................................................................................
P2_rs_nk2      ........................................................................................................................
P3_rs_pr1      ........................................................................................................................
P4_rs_pr2      ........................................................................................................................
P4_rs_pr3      ..............................................................T.........................................................
P5_rs_rc1      ........................................................................................................................
P5_rs_rc2      ........................................................................................................................
P5_rs_rc3      ........................................................................................................................
P6_rs_rc4      ........................................................................................................................
P6_rs_rc5      ........................................................................................................................
P6_rs_rc6      ........................................................................................................................
P6_rs_rc7      ........................................................................................................................
P6_rs_rc8      ........................................................................................................................
P7_rs_us1      ........................................................................................................................
P7_rs_us2      ........................................................................................................................
P8_rs_pr4      ........................................................................................................................
P9_rs_pr5      ........................................................................................................................
P10_cn_jl1     ........................................................................................................................
P10_cn_jl2     ........................................................................................................................
P11_cn_jl3     ........................................................................................................................
P11_cn_jl4     ........................................................................................................................
P12_cn_sn1     ........................................................................................................................
P12_cn_sn2     ........................................................................................................................
P13_cn_mc1     ........................................................................................................................
P13_cn_mc2     ........................................................................................................................
P14_kr_hw1     ........................................................................................................................
P14_kr_hw2     ........................................................................................................................
P15_kr_dm1     ........................................................................................................................
P15_kr_dm2     ........................................................................................................................
P15_kr_dm3     ........................................................................................................................
P16_kr_sk1     ........................................................................................................................
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P16_kr_sk3     ........................................................................................................................
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P16_kr_sk8     ........................................................................................................................
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P19_kr_gw1     ........................................................................................................................
P19_kr_gw2     ........................................................................................................................
P19_kr_gw3     ........................................................................................................................
P20_kr_ck1     ........................................................................................................................
P20_kr_ck2     ........................................................................................................................
P21_kr_hc1     ........................................................................................................................
P22_kr_hb1     ........................................................................................................................
P23_kr_hb2     ........................................................................................................................
P24_kr_mh1     ........................................................................................................................
P24_kr_mh2     ........................................................................................................................
p25_kr_tb1     ........................................................................................................................
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P26_kr_tb3     ........................................................................................................................
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P27_kr_so2     ........................................................................................................................
P27_kr_so3     ........................................................................................................................
P27_kr_so4     ........................................................................................................................
P27_kr_so5     ........................................................................................................................
P27_kr_so6     ........................................................................................................................
P28_kr_il1     ........................................................................................................................
P29_kr_mj1     ........................................................................................................................
P29_kr_mj2     ........................................................................................................................
P30_kr_dk1     ........................................................................................................................
P31_kr_jr1     ........................................................................................................................
O1_jp_rb1      ........................................................................................................................
O2_jp_hk1      ........................................................................................................................
O2_jp_hk2      ........................................................................................................................
O2_jp_hk3      ........................................................................................................................
O2_jp_hk4      ........................................................................................................................
J1_jp_hn1      ........................................................................................................................
J1_jp_hn2      ........................................................................................................................
J2_jp_ky1      ........................................................................................................................
J3_jp_jp1      ........................................................................................................................
B1_cn_bj1      ........................................................................................................................
B2_uk_1        ........................................................................................................................
AMP_cn_1       C.......................................................................................................................
SUF_kr_hl1     .............A...................................G......................................................................
SUF_kr_hl2     .............A...................................G......................................................................
```

Appendix 2. (Continued).

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                                                                                                                                    3240
A1_kr_gr1      AAATGTTCAGTTTCAAAATTACAATGGAAAAAAAAAGTAGTTCCTTCTATTCAATATCCTTATGGGGCCAAGAGGGACTAAAACCTATTAACAAAAATTTTAGTTTATTAACTTTCTTGCC
A1_kr_gr2      .........................................................................................................................
A2_kr_hl1      .........................................................................................................................
A2_kr_hl2      .........................................................................................................................
A2_kr_hl3      .........................................................................................................................
A2_kr_hl4      ................................................................................................T........................
A3_kr_hl5      .........................................................................................................................
A3_kr_hl6      .........................................................................................................................
A3_kr_hl7      .........................................................................................................................
A3_kr_hl8      .........................................................................................................................
A4_kr_hl9      .........................................................................................................................
A5_kr_hl10     .........................................................................................................................
A5_kr_hl11     .........................................................................................................................
A5_kr_hl12     .........................................................................................................................
A5_kr_hl13     .........................................................................................................................
A5_kr_hl14     .........................................................................................................................
A7_mn_1        .........................................................................................................................
A8_mn_2        .........................................................................................................................
M1_rs_kb1      .........................................................................................................................
M2_rs_kh1      .........................................................................................................................
M2_rs_kh2      .........................................................................................................................
M2_rs_kh3      .........................................................................................................................
M3_rs_kh4      .........................................................................................................................
M3_rs_kh5      .........................................................................................................................
M3_rs_kh6      .........................................................................................................................
M3_rs_kh7      .........................................................................................................................
M3_rs_kh8      .........................................................................................................................
M3_rs_kh9      .........................................................................................................................
M3_rs_kh10     .........................................................................................................................
M3_rs_kh11     .........................................................................................................................
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M3_rs_kh14     .........................................................................................................................
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M3_rs_kh18     .........................................................................................................................
M3_rs_kh19     .........................................................................................................................
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M3_rs_kh26     .........................................................................................................................
M3_rs_kh27     .........................................................................................................................
M3_rs_kh28     .........................................................................................................................
M3_rs_kh29     .........................................................................................................................
M3_rs_kh30     .........................................................................................................................
M3_rs_kh31     .........................................................................................................................
M4_rs_kh32     .........................................................................................................................
M5_rs_ot1      .........................................................................................................................
M6_rs_ri1      .........................................................................................................................
M6_rs_ri2      .........................................................................................................................
M7_cn_hj1      .........................................................................................................................
M8_cn_hj2      .........................................................................................................................
M8_cn_hj3      .........................................................................................................................
M8_cn_hj4      .........................................................................................................................
M9_cn_hj5      .........................................................................................................................
M10_cn_nm1     .........................................................................................................................
M11_cn_ul1     .........................................................................................................................
M12_cn_sb1     .........................................................................................................................
M12_cn_sb2     .........................................................................................................................
M13_kr_od1     .........................................................................................................................
M14_kr_jm1     .........................................................................................................................
M14_kr_jm2     .........................................................................................................................
M14_kr_jm3     .........................................................................................................................
M15_kr_dg1     .........................................................................................................................
M16_kr_dr1     .........................................................................................................................
M17_kr_sw1     .........................................................................................................................
M17_kr_sw2     .........................................................................................................................
M18_kr_hg1     .........................................................................................................................
M19_kr_gy1     .........................................................................................................................
M20_kr_nh1     .........................................................................................................................
M20_kr_nh2     .........................................................................................................................
M21_kr_gu1     .........................................................................................................................
M22_kr_mp1     .........................................................................................................................
M23_kr_bc1     .........................................................................................................................
M24_kr_os1     .........................................................................................................................
M25_kr_os2     .........................................................................................................................
M25_kr_os3     .........................................................................................................................
M25_kr_os4     .........................................................................................................................
M25_kr_os5     .........................................................................................................................
M26_kr_sn1     .........................................................................................................................
M27_kr_gn1     .........................................................................................................................
M27_kr_gn2     .........................................................................................................................
M28_kr_bs1     .........................................................................................................................
M28_kr_bs2     .........................................................................................................................
M28_kr_bs3     .........................................................................................................................
M29_kr_jn1     .........................................................................................................................
M30_kr_bl1     .........................................................................................................................
M30_kr_bl2     .........................................................................................................................
M31_kr_jl1     .........................................................................................................................
M31_kr_jl2     .........................................................................................................................
M32_kr_mt1     .........................................................................................................................
M33_kr_md1     .........................................................................................................................
M33_kr_md2     .........................................................................................................................
```

Appendix 2. (Continued).

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                                                                                                                                   3240
A1_kr_gr1      AAATGTTCAGTTTCAAAATTACAATGGAAAAAAAAGTAGTTCCTTCTATTCAATATCCTTATGGGGCCAAGAGGGACTAAAACCTATTAACAAAAATTTTAGTTTATTAACTTTCTTGCC
M34_kr_dn1     ........................................................................................................................
M34_kr_dn2     ........................................................................................................................
M35_kr_sm1     ........................................................................................................................
M35_kr_sm2     ........................................................................................................................
P1_rs_ms1      ........................................................................................................................
P1_rs_ms2      ........................................................................................................................
P1_rs_ms3      ........................................................................................................................
P1_rs_ms4      ........................................................................................................................
P2_rs_nk1      ........................................................................................................................
P2_rs_nk2      ........................................................................................................................
P3_rs_pr1      ........................................................................................................................
P4_rs_pr2      ........................................................................................................................
P4_rs_pr3      ........................................................................................................................
P5_rs_rc1      ........................................................................................................................
P5_rs_rc2      ........................................................................................................................
P5_rs_rc3      ........................................................................................................................
P6_rs_rc4      ........................................................................................................................
P6_rs_rc5      ........................................................................................................................
P6_rs_rc6      ........................................................................................................................
P6_rs_rc7      ........................................................................................................................
P6_rs_rc8      ........................................................................................................................
P7_rs_us1      ........................................................................................................................
P7_rs_us2      ........................................................................................................................
P8_rs_pr4      ........................................................................................................................
P9_rs_pr5      ........................................................................................................................
P10_cn_jl1     ........................................................................................................................
P10_cn_jl2     ........................................................................................................................
P11_cn_jl3     ........................................................................................................................
P11_cn_jl4     ........................................................................................................................
P12_cn_sn1     ........................................................................................................................
P12_cn_sn2     ........................................................................................................................
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P13_cn_mc2     ........................................................................................................................
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P19_kr_gw1     ........................................................................................................................
P19_kr_gw2     ........................................................................................................................
P19_kr_gw3     ........................................................................................................................
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P27_kr_so5     ........................................................................................................................
P27_kr_so6     ........................................................................................................................
P28_kr_il1     ........................................................................................................................
P29_kr_mj1     ........................................................................................................................
P29_kr_mj2     ........................................................................................................................
P30_kr_dk1     ........................................................................................................................
P31_kr_jr1     ........................................................................................................................
O1_jp_rb1      ........................................................................................................................
O2_jp_hk1      ........................................................................................................................
O2_jp_hk2      ........................................................................................................................
O2_jp_hk3      ........................................................................................................................
O2_jp_hk4      ........................................................................................................................
J1_jp_hn1      ........................................................................................................................
J1_jp_hn2      ........................................................................................................................
J2_jp_ky1      ........................................................................................................................
J3_jp_jp1      ........................................................................................................................
B1_cn_bj1      ........................................................................................................................
B2_uk_1         ........................................................................................................................
AMP_cn_1       ....................................................................................................C...................
SUF_kr_hl1     ............................................................................T.......................C..................A
SUF_kr_hl2     ............................................................................T.......................C..................A
```

Appendix 2. (Continued).

```
                                                                                                                                   3360
A1_kr_gr1      AAAAAAAAATAACGAAAGTGTTTCTAAGAATACACACGGAAATATAAAAAAAACGATGCGATCTTGTCTTTTTTTTTATAATTGTGACAATAAAAAATTTTCGACATACCCTCACGAATC
A1_kr_gr2      ........................................................................................................................
A2_kr_hl1      ........................................................................................................................
A2_kr_hl2      ........................................................................................................................
A2_kr_hl3      ........................................................................................................................
A2_kr_hl4      ........................................................................................................................
A3_kr_hl5      ........................................................................................................................
A3_kr_hl6      ........................................................................................................................
A3_kr_hl7      ........................................................................................................................
A3_kr_hl8      ........................................................................................................................
A4_kr_hl9      ........................................................................................................................
A5_kr_hl10     ........................................................................................................................
A5_kr_hl11     ........................................................................................................................
A5_kr_hl12     ........................................................................................................................
A5_kr_hl13     ........................................................................................................................
A5_kr_hl14     ........................................................................................................................
A7_mn_1        ........................................................................................................................
A8_mn_2        ........................................................................................................................
M1_rs_kb1      ........................................................................................................................
M2_rs_kh1      ........................................................................................................................
M2_rs_kh2      ........................................................................................................................
M2_rs_kh3      ........................................................................................................................
M3_rs_kh4      ........................................................................................................................
M3_rs_kh5      ........................................................................................................................
M3_rs_kh6      ........................................................................................................................
M3_rs_kh7      ........................................................................................................................
M3_rs_kh8      ........................................................................................................................
M3_rs_kh9      ........................................................................................................................
M3_rs_kh10     ........................................................................................................................
M3_rs_kh11     ........................................................................................................................
M3_rs_kh12     ........................................................................................................................
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M3_rs_kh29     ........................................................................................................................
M3_rs_kh30     ........................................................................................................................
M3_rs_kh31     ........................................................................................................................
M4_rs_kh32     ........................................................................................................................
M5_rs_ot1      ........................................................................................................................
M6_rs_ri1      ...............................................................................................................G........
M6_rs_ri2      ........................................................................................................................
M7_cn_hj1      ........................................................................................................................
M8_cn_hj2      ........................................................................................................................
M8_cn_hj3      ........................................................................................................................
M8_cn_hj4      ........................................................................................................................
M9_cn_hj5      ........................................................................................................................
M10_cn_nm1     ........................................................................................................................
M11_cn_ul1     ........................................................................................................................
M12_cn_sb1     ........................................................................................................................
M12_cn_sb2     ........................................................................................................................
M13_kr_od1     ........................................................................................................................
M14_kr_jm1     ........................................................................................................................
M14_kr_jm2     ........................................................................................................................
M14_kr_jm3     ........................................................................................................................
M15_kr_dg1     ........................................................................................................................
M16_kr_dr1     ........................................................................................................................
M17_kr_sw1     ........................................................................................................................
M17_kr_sw2     ........................................................................................................................
M18_kr_hg1     ........................................................................................................................
M19_kr_gy1     ........................................................................................................................
M20_kr_nh1     ........................................................................................................................
M20_kr_nh2     ........................................................................................................................
M21_kr_gu1     ........................................................................................................................
M22_kr_mp1     ........................................................................................................................
M23_kr_bc1     ........................................................................................................................
M24_kr_os1     ........................................................................................................................
M25_kr_os2     ........................................................................................................................
M25_kr_os3     ...............................................................................................................G........
M25_kr_os4     ........................................................................................................................
M25_kr_os5     ............................................A...........................................................................
M26_kr_sn1     ........................................................................................................................
M27_kr_gn1     ........................................................................................................................
M27_kr_gn2     ........................................................................................................................
M28_kr_bs1     ........................................................................................................................
M28_kr_bs2     ........................................................................................................................
M28_kr_bs3     ........................................................................................................................
M29_kr_jn1     ........................................................................................................................
M30_kr_bl1     ........................................................................................................................
M30_kr_bl2     ........................................................................................................................
M31_kr_jl1     ........................................................................................................................
M31_kr_jl2     ........................................................................................................................
M32_kr_mt1     ........................................................................................................................
M33_kr_md1     ........................................................................................................................
M33_kr_md2     ........................................................................................................................
```

Appendix 2. (Continued).

```
                                                                                                                                   3360
A1_kr_gr1      AAAAAAAAATAACGAAAGTGTTTCTAAGAATACACACGGAAATATAAAAAAAACGATGCGATCTTGTCTTTTTTTTTATAATTGTGACAATAAAAAATTTTCGACATACCCTCACGAATC
M34_kr_dn1     ........................................................................................................................
M34_kr_dn2     ........................................................................................................................
M35_kr_sm1     ........................................................................................................................
M35_kr_sm2     ........................................................................................................................
P1_rs_ms1      ........................................................................................................................
P1_rs_ms2      ........................................................................................................................
P1_rs_ms3      ........................................................................................................................
P1_rs_ms4      ........................................................................................................................
P2_rs_nk1      ........................................................................................................................
P2_rs_nk2      ........................................................................................................................
P3_rs_pr1      ........................................................................................................................
P4_rs_pr2      ........................................................................................................................
P4_rs_pr3      ...............................................................................................................G........
P5_rs_rc1      ........................................................................................................................
P5_rs_rc2      ........................................................................................................................
P5_rs_rc3      ........................................................................................................................
P6_rs_rc4      ........................................................................................................................
P6_rs_rc5      ........................................................................................................................
P6_rs_rc6      ........................................................................................................................
P6_rs_rc7      ........................................................................................................................
P6_rs_rc8      ........................................................................................................................
P7_rs_us1      .......................................................................................................................
P7_rs_us2      ........................................................................................................................
P8_rs_pr4      ........................................................................................................................
P9_rs_pr5      ........................................................................................................................
P10_cn_jl1     ........................................................................................................................
P10_cn_jl2     ........................................................................................................................
P11_cn_jl3     ........................................................................................................................
P11_cn_jl4     ........................................................................................................................
P12_cn_sn1     ........................................................................................................................
P12_cn_sn2     ........................................................................................................................
P13_cn_mc1     ........................................................................................................................
P13_cn_mc2     ........................................................................................................................
P14_kr_hw1     ........................................................................................................................
P14_kr_hw2     ........................................................................................................................
P15_kr_dm1     ........................................................................................................................
P15_kr_dm2     ........................................................................................................................
P15_kr_dm3     ........................................................................................................................
P16_kr_sk1     ........................................................................................................................
P16_kr_sk2     ........................................................................................................................
P16_kr_sk3     ........................................................................................................................
P16_kr_sk4     ........................................................................................................................
P16_kr_sk5     ............G...........................................................................................................
P16_kr_sk6     ........................................................................................................................
P16_kr_sk7     ........................................................................................................................
P16_kr_sk8     ........................................................................................................................
P17_kr_sh1     ........................................................................................................................
P18_kr_gb1     ........................................................................................................................
P19_kr_gw1     ............G...........................................................................................................
P19_kr_gw2     ............G...........................................................................................................
P19_kr_gw3     ........................................................................................................................
P20_kr_ck1     ........................................................................................................................
P20_kr_ck2     ........................................................................................................................
P21_kr_hc1     ........................................................................................................................
P22_kr_hb1     ........................................................................................................................
P23_kr_hb2     ........................................................................................................................
P24_kr_mh1     ........................................................................................................................
P24_kr_mh2     ........................................................................................................................
p25_kr_tb1     ........................................................................................................................
p25_kr_tb2     ........................................................................................................................
P26_kr_tb3     ........................................................................................................................
P27_kr_so1     ........................................................................................................................
P27_kr_so2     ........................................................................................................................
P27_kr_so3     ........................................................................................................................
P27_kr_so4     ........................................................................................................................
P27_kr_so5     ........................................................................................................................
P27_kr_so6     ........................................................................................................................
P28_kr_il1     ........................................................................................................................
P29_kr_mj1     ........................................................................................................................
P29_kr_mj2     ........................................................................................................................
P30_kr_dk1     ........................................................................................................................
P31_kr_jr1     ........................................................................................................................
O1_jp_rb1      ........................................................................................................................
O2_jp_hk1      .............................................................................T..........................................
O2_jp_hk2      ........................................................................................................................
O2_jp_hk3      ........................................................................................................................
O2_jp_hk4      ........................................................................................................................
J1_jp_hn1      ........................................................................................................................
J1_jp_hn2      ........................................................................................................................
J2_jp_ky1      ........................................................................................................................
J3_jp_jp1      ........................................................................................................................
B1_cn_bj1      ........................................................................................................................
B2_uk_1        .........A..............................................................................................................
AMP_cn_1       ...............................C...............................C.......................................C....T...........
SUF_kr_hl1     ...............................C...........C...................C...................................G...C....T...........
SUF_kr_hl2     ...............................C...........C...................C...................................G...C....T...........
```

Appendix 2. (Continued).

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                                                                                                                                   3480
A1_kr_gr1      AGACAATACTATGTTATTCCCGCTGCTTGTATTGATTTTATTTACTTTATTTATTGGAGTCATAGGAATTCCTTTCAACCAAGAAGGCATAGATTTGGATATATTGTCCAAATGGTTAAC
A1_kr_gr2      ........................................................................................................................
A2_kr_hl1      ........................................................................................................................
A2_kr_hl2      ........................................................................................................................
A2_kr_hl3      ........................................................................................................................
A2_kr_hl4      ........................................................................................................................
A3_kr_hl5      ........................................................................................................................
A3_kr_hl6      ........................................................................................................................
A3_kr_hl7      ........................................................................................................................
A3_kr_hl8      ........................................................................................................................
A4_kr_hl9      ........................................................................................................................
A5_kr_hl10     ........................................................................................................................
A5_kr_hl11     ........................................................................................................................
A5_kr_hl12     ........................................................................................................................
A5_kr_hl13     ........................................................................................................................
A5_kr_hl14     ........................................................................................................................
A7_mn_1        ........................................................................................................................
A8_mn_2        ........................................................................................................................
M1_rs_kb1      ........................................................................................................................
M2_rs_kh1      ........................................................................................................................
M2_rs_kh2      ........................................................................................................................
M2_rs_kh3      ........................................................................................................................
M3_rs_kh4      ........................................................................................................................
M3_rs_kh5      ........................................................................................................................
M3_rs_kh6      ........................................................................................................................
M3_rs_kh7      ........................................................................................................................
M3_rs_kh8      ........................................................................................................................
M3_rs_kh9      ........................................................................................................................
M3_rs_kh10     ........................................................................................................................
M3_rs_kh11     ........................................................................................................................
M3_rs_kh12     ........................................................................................................................
M3_rs_kh13     ........................................................................................................................
M3_rs_kh14     ........................................................................................................................
M3_rs_kh15     ........................................................................................................................
M3_rs_kh16     ........................................................................................................................
M3_rs_kh17     ........................................................................................................................
M3_rs_kh18     ........................................................................................................................
M3_rs_kh19     ........................................................................................................................
M3_rs_kh20     ........................................................................................................................
M3_rs_kh21     ........................................................................................................................
M3_rs_kh22     ........................................................................................................................
M3_rs_kh23     ........................................................................................................................
M3_rs_kh24     ........................................................................................................................
M3_rs_kh25     ........................................................................................................................
M3_rs_kh26     ........................................................................................................................
M3_rs_kh27     ........................................................................................................................
M3_rs_kh28     ........................................................................................................................
M3_rs_kh29     ........................................................................................................................
M3_rs_kh30     ........................................................................................................................
M3_rs_kh31     ........................................................................................................................
M4_rs_kh32     ........................................................................................................................
M5_rs_ot1      ........................................................................................................................
M6_rs_ri1      ........................................................................................................................
M6_rs_ri2      ........................................................................................................................
M7_cn_hj1      ........................................................................................................................
M8_cn_hj2      ........................................................................................................................
M8_cn_hj3      ........................................................................................................................
M8_cn_hj4      ........................................................................................................................
M9_cn_hj5      ........................................................................................................................
M10_cn_nm1     ........................................................................................................................
M11_cn_ul1     ........................................................................................................................
M12_cn_sb1     ........................................................................................................................
M12_cn_sb2     ........................................................................................................................
M13_kr_od1     ........................................................................................................................
M14_kr_jm1     ........................................................................................................................
M14_kr_jm2     ........................................................................................................................
M14_kr_jm3     ........................................................................................................................
M15_kr_dg1     ........................................................................................................................
M16_kr_dr1     ........................................................................................................................
M17_kr_sw1     ........................................................................................................................
M17_kr_sw2     ........................................................................................................................
M18_kr_hg1     ........................................................................................................................
M19_kr_gy1     ........................................................................................................................
M20_kr_nh1     ........................................................................................................................
M20_kr_nh2     ........................................................................................................................
M21_kr_gu1     ........................................................................................................................
M22_kr_mp1     ........................................................................................................................
M23_kr_bc1     ........................................................................................................................
M24_kr_os1     ........................................................................................................................
M25_kr_os2     ........................................................................................................................
M25_kr_os3     ........................................................................................................................
M25_kr_os4     ........................................................................................................................
M25_kr_os5     ........................................................................................................................
M26_kr_sn1     ........................................................................................................................
M27_kr_gn1     ........................................................................................................................
M27_kr_gn2     ........................................................................................................................
M28_kr_bs1     ........................................................................................................................
M28_kr_bs2     ........................................................................................................................
M28_kr_bs3     ........................................................................................................................
M29_kr_jn1     ........................................................................................................................
M30_kr_bl1     ........................................................................................................................
M30_kr_bl2     ........................................................................................................................
M31_kr_jl1     ............................A...........................................................................................
M31_kr_jl2     ........................................................................................................................
M32_kr_mt1     ........................................................................................................................
M33_kr_md1     ..........G.............................................................................................................
M33_kr_md2     ..........G.............................................................................................................
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Appendix 2. (Continued).

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                                                                                                                                      3480
A1_kr_gr1      AGACAATACTATGTTATTCCCGCTGCTTGTATTGATTTTATTTACTTTATTTATTGGAGTCATAGGAATTCCTTTCAACCAAGAAGGCATAGATTTGGATATATTGTCCAAATGGTTAAC
M34_kr_dn1     ........................................................................................................................
M34_kr_dn2     ........................................................................................................................
M35_kr_sm1     ........................................................................................................................
M35_kr_sm2     ........................................................................................................................
P1_rs_ms1      ........................................................................................................................
P1_rs_ms2      ........................................................................................................................
P1_rs_ms3      ........................................................................................................................
P1_rs_ms4      ........................................................................................................................
P2_rs_nk1      ........................................................................................................................
P2_rs_nk2      ........................................................................................................................
P3_rs_pr1      ........................................................................................................................
P4_rs_pr2      ........................................................................................................................
P4_rs_pr3      ........................................................................................................................
P5_rs_rc1      ........................................................................................................................
P5_rs_rc2      ........................................................................................................................
P5_rs_rc3      ........................................................................................................................
P6_rs_rc4      ........................................................................................................................
P6_rs_rc5      ........................................................................................................................
P6_rs_rc6      ........................................................................................................................
P6_rs_rc7      ........................................................................................................................
P6_rs_rc8      ........................................................................................................................
P7_rs_us1      ........................................................................................................................
P7_rs_us2      ........................................................................................................................
P8_rs_pr4      ........................................................................................................................
P9_rs_pr5      ........................................................................................................................
P10_cn_jl1     ........................................................................................................................
P10_cn_jl2     ........................................................................................................................
P11_cn_jl3     ........................................................................................................................
P11_cn_jl4     ........................................................................................................................
P12_cn_sn1     ........................................................................................................................
P12_cn_sn2     ........................................................................................................................
P13_cn_mc1     ........................................................................................................................
P13_cn_mc2     ........................................................................................................................
P14_kr_hw1     ........................................................................................................................
P14_kr_hw2     ........................................................................................................................
P15_kr_dm1     ........................................................................................................................
P15_kr_dm2     ........................................................................................................................
P15_kr_dm3     ........................................................................................................................
P16_kr_sk1     ........................................................................................................................
P16_kr_sk2     ........................................................................................................................
P16_kr_sk3     ........................................................................................................................
P16_kr_sk4     ........................................................................................................................
P16_kr_sk5     ........................................................................................................................
P16_kr_sk6     ........................................................................................................................
P16_kr_sk7     ........................................................................................................................
P16_kr_sk8     ........................................................................................................................
P17_kr_sh1     ........................................................................................................................
P18_kr_gb1     ........................................................................................................................
P19_kr_gw1     ........................................................................................................................
P19_kr_gw2     ........................................................................................................................
P19_kr_gw3     ........................................................................................................................
P20_kr_ck1     ........................................................................................................................
P20_kr_ck2     ........................................................................................................................
P21_kr_hc1     ........................................................................................................................
P22_kr_hb1     ........................................................................................................................
P23_kr_hb2     ........................................................................................................................
P24_kr_mh1     ........................................................................................................................
P24_kr_mh2     ........................................................................................................................
p25_kr_tb1     ........................................................................................................................
p25_kr_tb2     ........................................................................................................................
P26_kr_tb3     ........................................................................................................................
P27_kr_so1     ........................................................................................................................
P27_kr_so2     ........................................................................................................................
P27_kr_so3     ........................................................................................................................
P27_kr_so4     ........................................................................................................................
P27_kr_so5     ........................................................................................................................
P27_kr_so6     ........................................................................................................................
P28_kr_il1     ........................................................................................................................
P29_kr_mj1     ........................................................................................................................
P29_kr_mj2     ........................................................................................................................
P30_kr_dk1     ........................................................................................................................
P31_kr_jr1     ........................................................................................................................
O1_jp_rb1      .......................................................................................................................
O2_jp_hk1      ........................................................................................................................
O2_jp_hk2      ........................................................................................................................
O2_jp_hk3      ........................................................................................................................
O2_jp_hk4      ........................................................................................................................
J1_jp_hn1      ........................................................................................................................
J1_jp_hn2      ........................................................................................................................
J2_jp_ky1      ........................................................................................................................
J3_jp_jp1      ........................................................................................................................
B1_cn_bj1      ........................................................................................................................
B2_uk_1        ........................................................................................................................
AMP_cn_1       ...................................................C....................................................................
SUF_kr_hl1     ...................................................C......C.............................................................
SUF_kr_hl2     ...................................................C......C.............................................................
```

Appendix 2. (Continued).

```
                                                                                                                                   3600
A1_kr_gr1      CCCATCTATAAACCTTTTGCATCCAAAATGGAATAATCCAAAGAATTTTGATTGGGCGGAATTTGTAACAAATGCAACCTTTTCGGTTAGTATAGCTTATTCGGGAATAGTTATAGCGTT
A1_kr_gr2      ........................................................................................................................
A2_kr_hl1      ........................................................................................................................
A2_kr_hl2      ........................................................................................................................
A2_kr_hl3      ........................................................................................................................
A2_kr_hl4      ........................................................................................................................
A3_kr_hl5      ........................................................................................................................
A3_kr_hl6      ........................................................................................................................
A3_kr_hl7      ........................................................................................................................
A3_kr_hl8      ........................................................................................................................
A4_kr_hl9      ........................................................................................................................
A5_kr_hl10     ........................................................................................................................
A5_kr_hl11     ........................................................................................................................
A5_kr_hl12     ........................................................................................................................
A5_kr_hl13     ........................................................................................................................
A5_kr_hl14     ........................................................................................................................
A7_mn_1        ........................................................................................................................
A8_mn_2        ........................................................................................................................
M1_rs_kb1      ........................................................................................................................
M2_rs_kh1      ........................................................................C...............................................
M2_rs_kh2      ........................................................................C...............................................
M2_rs_kh3      ........................................................................C...............................................
M3_rs_kh4      ........................................................................C...............................................
M3_rs_kh5      ........................................................................C...............................................
M3_rs_kh6      ........................................................................................................................
M3_rs_kh7      ........................................................................................................................
M3_rs_kh8      ........................................................................C...............................................
M3_rs_kh9      ........................................................................................................................
M3_rs_kh10     ........................................................................................................................
M3_rs_kh11     ........................................................................................................................
M3_rs_kh12     ........................................................................................................................
M3_rs_kh13     ........................................................................................................................
M3_rs_kh14     ........................................................................................................................
M3_rs_kh15     ........................................................................C...............................................
M3_rs_kh16     ........................................................................C...............................................
M3_rs_kh17     ........................................................................C...............................................
M3_rs_kh18     ........................................................................................................................
M3_rs_kh19     ........................................................................C...............................................
M3_rs_kh20     ........................................................................................................................
M3_rs_kh21     ........................................................................C...............................................
M3_rs_kh22     ........................................................................C...............................................
M3_rs_kh23     ........................................................................................................................
M3_rs_kh24     ........................................................................C...............................................
M3_rs_kh25     ........................................................................C...............................................
M3_rs_kh26     ........................................................................................................................
M3_rs_kh27     ........................................................................C...............................................
M3_rs_kh28     ........................................................................C...............................................
M3_rs_kh29     ........................................................................C...............................................
M3_rs_kh30     ........................................................................................................................
M3_rs_kh31     ........................................................................C...............................................
M4_rs_kh32     ........................................................................C...............................................
M5_rs_ot1      ...........C.................T..........................................................................................
M6_rs_ri1      .............................T..........................................................................................
M6_rs_ri2      ........................................................................................................................
M7_cn_hj1      ........................................................................................................................
M8_cn_hj2      ........................................................................................................................
M8_cn_hj3      ........................................................................................................................
M8_cn_hj4      ........................................................................................................................
M9_cn_hj5      ........................................................................................................................
M10_cn_nm1     ........................................................................................................................
M11_cn_ul1     ........................................................................................................................
M12_cn_sb1     ........................................................................................................................
M12_cn_sb2     ........................................................................................................................
M13_kr_od1     ........................................................................................................................
M14_kr_jm1     .............................T..........................................................................................
M14_kr_jm2     .............................T..........................................................................................
M14_kr_jm3     .............................T..........................................................................................
M15_kr_dg1     ........................................................................................................................
M16_kr_dr1     ........................................................................................................................
M17_kr_sw1     ........................................................................................................................
M17_kr_sw2     ........................................................................................................................
M18_kr_hg1     ........................................................................................................................
M19_kr_gy1     ........................................................................................................................
M20_kr_nh1     .............................T..........................................................................................
M20_kr_nh2     .............................T..........................................................................................
M21_kr_gu1     ........................................................................................................................
M22_kr_mp1     ........................................................................................................................
M23_kr_bc1     ........................................................................................................................
M24_kr_os1     ........................................................................................................................
M25_kr_os2     ........................................................................................................................
M25_kr_os3     .............................T..........................................................................................
M25_kr_os4     ........................................................................................................................
M25_kr_os5     ........................................................................................................................
M26_kr_sn1     ........................................................................................................................
M27_kr_gn1     ........................................................................................................................
M27_kr_gn2     ........................................................................................................................
M28_kr_bs1     .............................T..........................................................................................
M28_kr_bs2     ........................................................................................................................
M28_kr_bs3     .............................T..........................................................................................
M29_kr_jn1     ........................................................................................................................
M30_kr_bl1     ........................................................................................................................
M30_kr_bl2     .............................T..........................................................................................
M31_kr_jl1     .............................T..........................................................................................
M31_kr_jl2     ........................................................................................................................
M32_kr_mt1     ........................................................................................................................
M33_kr_md1     ........................................................................................................................
M33_kr_md2     ........................................................................................................................
```

Appendix 2. (Continued).

```
                                                                                                                                  3600
A1_kr_gr1      CCCATCTATAAACCTTTTGCATCCAAAATGGAATAATCCAAAGAATTTTGATTGGGCGGAATTTGTAACAAATGCAACCTTTTCGGTTAGTATAGCTTATTCGGGAATAGTTATAGCGTT
M34_kr_dn1     ........................................................................................................................
M34_kr_dn2     ........................................................................................................................
M35_kr_sm1     ........................................................................................................................
M35_kr_sm2     ........................................................................................................................
P1_rs_ms1      ........................................................................................................................
P1_rs_ms2      ........................................................................................................................
P1_rs_ms3      ........................................................................................................................
P1_rs_ms4      ........................................................................................................................
P2_rs_nk1      ........................................................................................................................
P2_rs_nk2      ........................................................................................................................
P3_rs_pr1      ........................................................................................................................
P4_rs_pr2      ........................................................................................................................
P4_rs_pr3      .............................T..........................................................................................
P5_rs_rc1      ...........C.................T..........................................................................................
P5_rs_rc2      ........................................................................................................................
P5_rs_rc3      ........................................................................................................................
P6_rs_rc4      .............................T..........................................................................................
P6_rs_rc5      .............................T..........................................................................................
P6_rs_rc6      .............................T..........................................................................................
P6_rs_rc7      .............................T..........................................................................................
P6_rs_rc8      ........................................................................................................................
P7_rs_us1      ........................................................................................................................
P7_rs_us2      ........................................................................................................................
P8_rs_pr4      ........................................................................................................................
P9_rs_pr5      ...........C.................T..........................................................................................
P10_cn_jl1     ........................................................................................................................
P10_cn_jl2     ........................................................................................................................
P11_cn_jl3     .............................T..........................................................................................
P11_cn_jl4     ........................................................................................................................
P12_cn_sn1     .......................................................................................................................
P12_cn_sn2     ........................................................................................................................
P13_cn_mc1     ........................................................................................................................
P13_cn_mc2     ........................................................................................................................
P14_kr_hw1     ........................................................................................................................
P14_kr_hw2     ........................................................................................................................
P15_kr_dm1     ........................................................................................................................
P15_kr_dm2     ........................................................................................................................
P15_kr_dm3     ........................................................................................................................
P16_kr_sk1     .....................................................................................................................A..
P16_kr_sk2     .....................................................................................................................A..
P16_kr_sk3     .....................................................................................................................A..
P16_kr_sk4     .....................................................................................................................A..
P16_kr_sk5     ........................................................................................................................
P16_kr_sk6     .....................................................................................................................A..
P16_kr_sk7     .....................................................................................................................A..
P16_kr_sk8     .....................................................................................................................A..
P17_kr_sh1     ........................................................................................................................
P18_kr_gb1     ........................................................................................................................
P19_kr_gw1     ........................................................................................................................
P19_kr_gw2     ........................................................................................................................
P19_kr_gw3     ........................................................................................................................
P21_kr_hc1     ........................................................................................................................
P20_kr_ck1     ........................................................................................................................
P20_kr_ck2     ........................................................................................................................
P22_kr_hb1     ........................................................................................................................
P23_kr_hb2     .........................................................................................................................
P24_kr_mh1     ........................................................................................................................
P24_kr_mh2     ........................................................................................................................
p25_kr_tb1     ........................................................................................................................
p25_kr_tb2     ........................................................................................................................
P26_kr_tb3     ........................................................................................................................
P27_kr_so1     ........................................................................................................................
P27_kr_so2     ........................................................................................................................
P27_kr_so3     ........................................................................................................................
P27_kr_so4     ........................................................................................................................
P27_kr_so5     ........................................................................................................................
P27_kr_so6     ........................................................................................................................
P28_kr_il1     ........................................................................................................................
P29_kr_mj1     ........................................................................................................................
P29_kr_mj2     ........................................................................................................................
P30_kr_dk1     ........................................................................................................................
P31_kr_jr1     ........................................................................................................................
O1_jp_rb1      .......................................................................................................................
O2_jp_hk1      ........................................................................C...............................................
O2_jp_hk2      ........................................................................................................................
O2_jp_hk3      ........................................................................................................................
O2_jp_hk4      ........................................................................................................................
J1_jp_hn1      ........................................................................................................................
J1_jp_hn2      ........................................................................................................................
J2_jp_ky1      .............................T..........................................................................................
J3_jp_jp1      ........................................................................................................................
B1_cn_bj1      .............................T..........................................................................................
B2_uk_1        .............................T..........................................................................................
AMP_cn_1       .............................TT......A.................................................................................C
SUF_kr_hl1     .............................T.........................................................................................C
SUF_kr_hl2     .............................T.........................................................................................C
```

Appendix 2. (Continued).

```
                                                                                                                                    3720
A1_kr_gr1    TTTTTTATATAAACCCGTTTATTCATCCTTACAAAATTTTGTCTTAATTAATTATTTTGCCAAAAGGCACCCAAATCGGGGTTTTTCAGACAAAATAAAAAATTTAATATATGATTGGGC
A1_kr_gr2    ........................................................................................................................
A2_kr_hl1    ........................................................................................................................
A2_kr_hl2    ........................................................................................................................
A2_kr_hl3    ........................................................................................................................
A2_kr_hl4    ........................................................................................................................
A3_kr_hl5    ........................................................................................................................
A3_kr_hl6    ........................................................................................................................
A3_kr_hl7    ........................................................................................................................
A3_kr_hl8    ........................................................................................................................
A4_kr_hl9    ........................................................................................................................
A5_kr_hl10   ........................................................................................................................
A5_kr_hl11   ........................................................................................................................
A5_kr_hl12   ........................................................................................................................
A5_kr_hl13   ........................................................................................................................
A5_kr_hl14   ........................................................................................................................
A7_mn_1      ........................................................................................................................
A8_mn_2      ........................................................................................................................
M1_rs_kb1    ........................................................................................................................
M2_rs_kh1    ........................................................................................................................
M2_rs_kh2    ........................................................................................................................
M2_rs_kh3    ........................................................................................................................
M3_rs_kh4    ........................................................................................................................
M3_rs_kh5    ........................................................................................................................
M3_rs_kh6    ........................................................................................................................
M3_rs_kh7    ........................................................................................................................
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M3_rs_kh9    ........................................................................................................................
M3_rs_kh10   ........................................................................................................................
M3_rs_kh11   ........................................................................................................................
M3_rs_kh12   ........................................................................................................................
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M3_rs_kh14   ........................................................................................................................
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M3_rs_kh30   ........................................................................................................................
M3_rs_kh31   ........................................................................................................................
M4_rs_kh32   ........................................................................................................................
M5_rs_ot1    ........................................................................................................................
M6_rs_ri1    .......................................................................A................................................
M6_rs_ri2    ........................................................................................................................
M7_cn_hj1    ......T.................................................................................................................
M8_cn_hj2    ........................................................................................................................
M8_cn_hj3    ........................................................................................................................
M8_cn_hj4    ........................................................................................................................
M9_cn_hj5    ........................................................................................................................
M10_cn_nm1   .................................................................................................C......................
M11_cn_ul1   ........................................................................................................................
M12_cn_sb1   ........................................................................................................................
M12_cn_sb2   ........................................................................................................................
M13_kr_od1   ........................................................................................................................
M14_kr_jm1   ........................................................................................................................
M14_kr_jm2   ........................................................................................................................
M14_kr_jm3   ........................................................................................................................
M15_kr_dg1   ......T.................................................................................................................
M16_kr_dr1   ........................................................................................................................
M17_kr_sw1   ........................................................................................................................
M17_kr_sw2   ........................................................................................................................
M18_kr_hg1   ........................................................................................................................
M19_kr_gy1   ........................................................................................................................
M20_kr_nh1   ........................................................................................................................
M20_kr_nh2   ........................................................................................................................
M21_kr_gu1   ........................................................................................................................
M22_kr_mp1   ........................................................................................................................
M23_kr_bc1   ........................................................................................................................
M24_kr_os1   ........................................................................................................................
M25_kr_os2   ........................................................................................................................
M25_kr_os3   .......................................................................A................................................
M25_kr_os4   ........................................................................................................................
M25_kr_os5   ........................................................................................................................
M26_kr_sn1   ........................................................................................................................
M27_kr_gn1   ........................................................................................................................
M27_kr_gn2   ........................................................................................................................
M28_kr_bs1   ...............................................................C........................................................
M28_kr_bs2   ........................................................................................................................
M28_kr_bs3   ...............................................................C........................................................
M29_kr_jn1   .......................................................................................................................
M30_kr_bl1   ........................................................................................................................
M30_kr_bl2   ........................................................................................................................
M31_kr_jl1   ........................................................................................................................
M31_kr_jl2   ........................................................................................................................
M32_kr_mt1   ........................................................................................................................
M33_kr_md1   ........................................................................................................................
M33_kr_md2   ........................................................................................................................
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Appendix 2. (Continued).

```
                                                                                                                                   3720
A1_kr_gr1      TTTTTTATATAAACCCGTTTATTCATCCTTACAAAATTTTGTCTTAATTAATTATTTTGCCAAAAGGCACCCAAATCGGGGTTTTTCAGACAAAATAAAAAATTTAATATATGATTGGGC
M34_kr_dn1     ........................................................................................................................
M34_kr_dn2     ........................................................................................................................
M35_kr_sm1     ........................................................................................................................
M35_kr_sm2     ........................................................................................................................
P1_rs_ms1      ........................................................................................................................
P1_rs_ms2      ........................................................................................................................
P1_rs_ms3      ........................................................................................................................
P1_rs_ms4      ........................................................................................................................
P2_rs_nk1      ........................................................................................................................
P2_rs_nk2      ........................................................................................................................
P3_rs_pr1      ........................................................................................................................
P4_rs_pr2      ........................................................................................................................
P4_rs_pr3      .......................................................................A................................................
P5_rs_rc1      ........................................................................................................................
P5_rs_rc2      ........................................................................................................................
P5_rs_rc3      ........................................................................................................................
P6_rs_rc4      ...............................................................C........................................................
P6_rs_rc5      ...............................................................C........................................................
P6_rs_rc6      ...............................................................C........................................................
P6_rs_rc7      ...............................................................C........................................................
P6_rs_rc8      ........................................................................................................................
P7_rs_us1      ........................................................................................................................
P7_rs_us2      ........................................................................................................................
P8_rs_pr4      ........................................................................................................................
P9_rs_pr5      ........................................................................................................................
P10_cn_jl1     ........................................................................................................................
P10_cn_jl2     ........................................................................................................................
P11_cn_jl3     ...............................................................C........................................................
P11_cn_jl4     ........................................................................................................................
P12_cn_sn1     ........................................................................................................................
P12_cn_sn2     ........................................................................................................................
P13_cn_mc1     ........................................................................................................................
P13_cn_mc2     ........................................................................................................................
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P14_kr_hw2     ........................................................................................................................
P15_kr_dm1     ........................................................................................................................
P15_kr_dm2     ........................................................................................................................
P15_kr_dm3     ........................................................................................................................
P16_kr_sk1     ........................................................................................................................
P16_kr_sk2     ........................................................................................................................
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P16_kr_sk6     ........................................................................................................................
P16_kr_sk7     ........................................................................................................................
P16_kr_sk8     ........................................................................................................................
P17_kr_sh1     ........................................................................................................................
P18_kr_gb1     ........................................................................................................................
P19_kr_gw1     ........................................................................................................................
P19_kr_gw2     ........................................................................................................................
P19_kr_gw3     ........................................................................................................................
P20_kr_ck1     ........................................................................................................................
P20_kr_ck2     ........................................................................................................................
P21_kr_hc1     ........................................................................................................................
P22_kr_hb1     ........................................................................................................................
P23_kr_hb2     ........................................................................................................................
P24_kr_mh1     ........................................................................................................................
P24_kr_mh2     ........................................................................................................................
p25_kr_tb1     ........................................................................................................................
p25_kr_tb2     ........................................................................................................................
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P27_kr_so2     ........................................................................................................................
P27_kr_so3     ........................................................................................................................
P27_kr_so4     ........................................................................................................................
P27_kr_so5     ........................................................................................................................
P27_kr_so6     ........................................................................................................................
P28_kr_il1     ........................................................................................................................
P29_kr_mj1     ........................................................................................................................
P29_kr_mj2     ........................................................................................................................
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P31_kr_jr1     ........................................................................................................................
O1_jp_rb1      ........................................................................................................................
O2_jp_hk1      ........................................................................................................................
O2_jp_hk2      ........................................................................................................................
O2_jp_hk3      ........................................................................................................................
O2_jp_hk4      ........................................................................................................................
J1_jp_hn1      ........................................................................................................................
J1_jp_hn2      ........................................................................................................................
J2_jp_ky1      ........................................................................................................................
J3_jp_jp1      ........................................................................................................................
B1_cn_bj1      ........................................................................................................................
B2_uk_1        ........................................................................................................................
AMP_cn_1       .........................................C..................................A...........................................
SUF_kr_hl1     .........................................C..................................A...........................................
SUF_kr_hl2     .........................................C..................................A...........................................
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Appendix 2. (Continued).

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                                                                                              3803
A1_kr_gr1      CCATCATCGTGGTTACATAGATGCTTTTTATACAACATATGTAATTCGGAGTGTAAGAGGATTGTCCGAACTAGTTCATTTTT      [3801]
A1_kr_gr2      ...................................................................................      [3801]
A2_kr_hl1      .......A...........................................................................      [3801]
A2_kr_hl2      ...................................................................................      [3801]
A2_kr_hl3      ...............................................................A...................      [3801]
A2_kr_hl4      ......................................G............................................      [3801]
A3_kr_hl5      ...................................................................................      [3801]
A3_kr_hl6      ...............................................................A...................      [3801]
A3_kr_hl7      ......................................G............................................      [3801]
A3_kr_hl8      ......................................G............................................      [3801]
A4_kr_hl9      ...................................................................................      [3801]
A5_kr_hl10     ...................................................................................      [3801]
A5_kr_hl11     ...............................................................A...................      [3801]
A5_kr_hl12     ...................................................................................      [3801]
A5_kr_hl13     ...............................................................A...................      [3801]
A5_kr_hl14     ...................................................................................      [3801]
A7_mn_1        ...................................................................................      [3801]
A8_mn_2        ...................................................................................      [3801]
M1_rs_kb1      ...................................................................................      [3801]
M2_rs_kh1      ...................................................................................      [3801]
M2_rs_kh2      ...................................................................................      [3801]
M2_rs_kh3      ...................................................................................      [3801]
M3_rs_kh4      ...................................................................................      [3801]
M3_rs_kh5      ...................................................................................      [3801]
M3_rs_kh6      ...................................................................................      [3801]
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M3_rs_kh8      ...................................................................................      [3801]
M3_rs_kh9      ...................................................................................      [3801]
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M3_rs_kh28     ...................................................................................      [3801]
M3_rs_kh29     ...................................................................................      [3801]
M3_rs_kh30     ...................................................................................      [3801]
M3_rs_kh31     ...................................................................................      [3801]
M4_rs_kh32     ...................................................................................      [3801]
M5_rs_ot1      ...................................................................................      [3801]
M6_rs_ri1      ...................................................................................      [3801]
M6_rs_ri2      ...................................................................................      [3801]
M7_cn_hj1      ...................................................................................      [3801]
M8_cn_hj2      ...................................................................................      [3801]
M8_cn_hj3      ...................................................................................      [3801]
M8_cn_hj4      ...................................................................................      [3801]
M9_cn_hj5      ...................................................................................      [3801]
M10_cn_nm1     ...................................................................................      [3801]
M11_cn_ul1     ...................................................................................      [3801]
M12_cn_sb1     ...................................................................................      [3801]
M12_cn_sb2     ...................................................................................      [3801]
M13_kr_od1     ...................................................................................      [3801]
M14_kr_jm1     ...................................................................................      [3801]
M14_kr_jm2     ...................................................................................      [3801]
M14_kr_jm3     ...................................................................................      [3801]
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M16_kr_dr1     ...................................................................................      [3801]
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M19_kr_gy1     ...................................................................................      [3801]
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M20_kr_nh2     ...................................................................................      [3801]
M21_kr_gu1     ...................................................................................      [3801]
M22_kr_mp1     ...................................................................................      [3801]
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M25_kr_os2     ...................................................................................      [3801]
M25_kr_os3     ...................................................................................      [3801]
M25_kr_os4     ...................................................................................      [3801]
M25_kr_os5     ...................................................................................      [3802]
M26_kr_sn1     ...................................................................................      [3801]
M27_kr_gn1     ...................................................................................      [3801]
M27_kr_gn2     ...................................................................................      [3801]
M28_kr_bs1     ...................................................................................      [3801]
M28_kr_bs2     ...................................................................................      [3801]
M28_kr_bs3     ...................................................................................      [3801]
M29_kr_jn1     ...................................................................................      [3801]
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M30_kr_bl2     ...................................................................................      [3801]
M31_kr_jl1     ...................................................................................      [3801]
M31_kr_jl2     ...................................................................................      [3801]
M32_kr_mt1     ...................................................................................      [3801]
M33_kr_md1     ...................................................................................      [3801]
M33_kr_md2     ...................................................................................      [3801]
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Appendix 2. (Continued).

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                                                                                              3803
A1_kr_gr1      CCATCATCGTGGTTACATAGATGCTTTTTATACAACATATGTAATTCGGAGTGTAAGAGGATTGTCCGAACTAGTTCATTTTT      [3801]
M34_kr_dn1     ...................................................................................      [3801]
M34_kr_dn2     ...................................................................................      [3801]
M35_kr_sm1     ...................................................................................      [3801]
M35_kr_sm2     ...................................................................................      [3801]
P1_rs_ms1      ...................................................................................      [3801]
P1_rs_ms2      ...................................................................................      [3801]
P1_rs_ms3      ...................................................................................      [3801]
P1_rs_ms4      ...................................................................................      [3801]
P2_rs_nk1      ...................................................................................      [3801]
P2_rs_nk2      ...................................................................................      [3801]
P3_rs_pr1      ...................................................................................      [3801]
P4_rs_pr2      ...................................................................................      [3801]
P4_rs_pr3      ...................................................................................      [3801]
P5_rs_rc1      ...................................................................................      [3801]
P5_rs_rc2      ...................................................................................      [3801]
P5_rs_rc3      ...................................................................................      [3801]
P6_rs_rc4      ...................................................................................      [3801]
P6_rs_rc5      ...................................................................................      [3801]
P6_rs_rc6      ...................................................................................      [3801]
P6_rs_rc7      ...................................................................................      [3801]
P6_rs_rc8      ...................................................................................      [3801]
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P7_rs_us2      ...................................................................................      [3801]
P8_rs_pr4      ...................................................................................      [3801]
P9_rs_pr5      ...................................................................................      [3801]
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P11_cn_jl4     ...................................................................................      [3801]
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P13_cn_mc2     ...................................................................................      [3801]
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P14_kr_hw2     ...................................................................................      [3801]
P15_kr_dm1     .......A...........................................................................      [3801]
P15_kr_dm2     .......A...........................................................................      [3801]
P15_kr_dm3     .......A...........................................................................      [3801]
P16_kr_sk1     ...................................................................................      [3801]
P16_kr_sk2     ...................................................................................      [3801]
P16_kr_sk3     ...................................................................................      [3801]
P16_kr_sk4     ...................................................................................      [3801]
P16_kr_sk5     ...................................................................................      [3801]
P16_kr_sk6     ...................................................................................      [3801]
P16_kr_sk7     ...................................................................................      [3801]
P16_kr_sk8     ...................................................................................      [3801]
P17_kr_sh1     .......A...........................................................................      [3801]
P18_kr_gb1     ...................................................................................      [3801]
P19_kr_gw1     ...................................................................................      [3801]
P19_kr_gw2     ...................................................................................      [3801]
P19_kr_gw3     ...................................................................................      [3801]
P20_kr_ck1     ...................................................................................      [3801]
P20_kr_ck2     ...................................................................................      [3801]
P21_kr_hc1     ...................................................................................      [3801]
P22_kr_hb1     ...................................................................................      [3801]
P23_kr_hb2     ...................................................................................      [3801]
P24_kr_mh1     ...................................................................................      [3801]
P24_kr_mh2     ...................................................................................      [3801]
p25_kr_tb1     ...................................................................................      [3801]
p25_kr_tb2     ...................................................................................      [3801]
P26_kr_tb3     ...................................................................................      [3801]
P27_kr_so1     ...................................................................................      [3801]
P27_kr_so2     ...................................................................................      [3801]
P27_kr_so3     ...................................................................................      [3801]
P27_kr_so4     ...................................................................................      [3801]
P27_kr_so5     ...................................................................................      [3801]
P27_kr_so6     ...................................................................................      [3801]
P28_kr_il1     ...................................................................................      [3801]
P29_kr_mj1     ...................................................................................      [3801]
P29_kr_mj2     ...................................................................................      [3801]
P30_kr_dk1     ...................................................................................      [3801]
P31_kr_jr1     ...................................................................................      [3801]
O1_jp_rb1      ...................................................................................      [3801]
O2_jp_hk1      ...................................................................................      [3801]
O2_jp_hk2      ...................................................................................      [3801]
O2_jp_hk3      ...................................................................................      [3801]
O2_jp_hk4      ...................................................................................      [3801]
J1_jp_hn1      ...................................................................................      [3801]
J1_jp_hn2      ...................................................................................      [3801]
J2_jp_ky1      ...................................................................................      [3801]
J3_jp_jp1      ...................................................................................      [3801]
B1_cn_bj1      ...................................................................................      [3801]
B2_uk_1        ...................................................................................      [3801]
AMP_cn_1       .......................T...........................................................      [3796]
SUF_kr_hl1     ..................C................................................................      [3802]
SUF_kr_hl2     ..................C................................................................      [3802]
```

국문초록

Bistorta manshuriensis complex는 동북아 지역 (한반도, 중국 동북부, 러시아 극동 및 일본)에 분포하는 형태학적으로 매우 유연관계가 깊은 또는 변이가 복잡한 5개 분류군을 포함한다. 본 complex 내에는 계통분류학적으로 많은 문제점이 누적되어 있다. 본 *B. manshuriensis* complex 분류군의 한계 및 실체와 종간 유연관계를 규명하기 위해 주요 형태형질 연구 및 DNA 염기서열을 분석하였다. 주성분 분석을 포함한 비교 형태분석 결과, 본 complex에 속하는 분류군들은 잎의 형태, 길이, 최대폭, 엽병 날개 길이 등에 의해 서로 약하게 구분되는 것으로 나타났다. 조사된 *B. manshuriensis* complex 분류군에서 체세포 염색체 수는 2배체($2n$ = 24)와 4배체($2n$ = 48)로 확인되었다. 본 연구에서 조사된 *B. manshuriensis* complex 분류군 중에서 *B. manshuriensis*와 *B. alopecuroides*의 염색체 수는 처음으로 조사되었다. 본 complex 분류군들의 핵 ITS 및 엽록체 DNA 6개 구간 염기서열 분석을 위해 동북아 지역에 걸쳐 채집된 *B. manshuriensis* complex 분류군들의 82개체군 182개체를 이용하였다. 핵 ITS염기서열의 22개 substitution과 1개 indel을 근거로, 본 complex 내에는 28개의 ribotype이 존재하는 것으로 밝혀졌다. 본 complex의 경우, 분류군 및 지역집단 수준에서 핵 DNA ribotype polymorphism이 높은 것으로 나타났다. 한편, 28개 ribotype 중에는, 일부 분류군간에 공통적으로 분포하는 ITS ribotype이 존재하는 것으로 밝혀졌다. 엽록체 DNA 염기서열에 나타나는 64개의 substitution과 1개의 indel에 근거하여 본 complex 내에서 43개의 haplotype이 존재하는 것으로 밝혀졌다. 본 complex의 일부 분류군 간에는 공통적으로 분포하는 최소한 8개의 엽록체 DNA haplotype이

발견된다. TCS haplotype network와 계통수를 근거하여 본 complex에서 많은 lineage가 존재하는 것이 밝혀졌다. 그러나, lineage가 현재 인식되어 있는 분류군에 대해서 관계가 일치하지 않았다. 이러한 결과로 볼 때, 본 complex 분류군들은 하나의 공통조상에서 기원하였으나, 조상 분류군에 존재하던 유전적 다형성이 불완전 계통 분립(incomplete lineage sorting)에 의해 전이되면서 현재와 같은 복잡한 양상으로 분화된 것으로 추정된다. 본 연구에서는 상기한 결과들을 종합하여 *B. manshuriensis* complex를 3종 2아종으로 정리하고, 검색표 및 기재를 작성하여 분류학적 처리를 수행하였다.

Keywords: *Bistorta manshuriensis*, cpDNA, haplotype, ITS, 동북아 지역

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This work would not have been possible without the financial support of Brain Korea 21 scholarship, National Research Foundation of Korea and Eco-Innovation Project of the Ministry of Environment, Korea.

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이학박사학위논문

Phylogeny and Systematics of the *Bistorta manshuriensis* Complex (Polygonaceae)

Bistorta manshuriensis Complex (마디풀과)의 계통과 분류

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GAURI SHANKAR BHANDARI

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Bistorta manshuriensis Complex (마디풀과)의 계통과 분류

지도교수 박 종 욱

A dissertation submitted in partial fulfilment of the requirements for the degree of

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by

Gauri Shankar Bhandari

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Abstract

Phylogeny and Systematics of the *Bistorta manshuriensis* complex (Polygonaceae)

Gauri Shankar Bhandari
School of Biological Sciences
College of Natural Sciences
Seoul National University

The *Bistorta manshuriensis* species complex consists of five closely related and morphologically variable taxa distributed in northeast Asia including Russian Far East, northeast China, Korea and Japan. Taxonomic identity and species delimitations have been problematic in the complex. To delimit species boundaries, and to clarify taxonomic postion and phylogenetic relationships within the *B. manshuriensis* complex, major morphological characters were examined and DNA sequences were analyzed. The results of morphological analyses show that the length and width of leaf blade, position of maximum width in the leaf blade ratio between length and width of leaf blade, length of petiole wing are useful characteristics in distinguishing the taxa of the complex. Study of leaf epidermal surface using Scanning Electron Microscope showed that epicuticular wax and stomatal density was variable among the taxa. Somatic chromosome counts revealed diploids (2*n* = 24) and tetraploids (2*n* = 48) in the complex. The chromosome counts reported herein represented the first reports for *B. manshuriensis* and *B. alopecuroides*. Variations in ITS and cpDNA regions were examined in 182 accessions sampled from 82 populations from almost the entire distribution area of the taxa of the *B. manshuriensis* complex. Twenty eight ribotypes were identified on the basis of 22 substitutions and one indel in the ITS. Ribotype polymorphism was prevalent in all taxa of the complex and in majority of the populations. A geographically widespread ribotype, distributed in all populations except two populations in Korea, was detected. Among 28 ribotypes identified in the complex, eight were shared by two or more taxa and 13 ribotypes were population-specific. Forty three haplotypes were identified on the bases of 64 nucleotide substitutions and one indel in the combined cpDNA sequence data. Eight haplotypes were shared by two or more taxa of the complex, and 27 haplotypes were population-specific. A geographically widespread haplotype distributed in 34 populations was detected in the complex. TCS haplotype network and phylogenetic tree analyses inferred from the combined cpDNA sequence data indicated several lineages in the complex. However, no lineage corresponded to the currently recognized delimitations of taxa suggesting that the speciation in the *B. manshuriensis* complex involved a complex pattern of hybridization, incomplete lineage sorting, mutations and geographical divergence. Based on morphological, cytological and molecular results, three species and two subspecies were recognized in the *B. manshuriensis* complex in northeast Asia and the description of all taxa and keys to the taxa are provided.

***Keywords* - *Bistorta manshuriensis*, cpDNA, haplotype, ITS, northeast Asia**

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I. Introduction

The genus *Bistorta* [(L.) Scop.] (Polygonaceae) comprises 30 to 50 species (Yonekura and Ohashi, 2001; Li et al. 2003; Freeman and Hinds, 2005; Galasso et al., 2009) distributed primarily in the temperate and alpine regions of the Northern Hemisphere including Asia, Europe and North America. The primary center of diversity of *Bistorta* is in the Himalaya and adjacent regions, which contain about two-thirds of the species (Yonekura and Ohashi, 2001). The genus comprises about 15 taxa in northeast Asia. Among them, nine species are in the Russian Far East (Tzvelev, 1989), seven species are in northeast China (Li et al., 2003) and six species are in Japan (Yonekura, 2006). On the Korean peninsula, nine species of *Bistorta* have been reported, with one species described as being endemic (Nakai, 1938; Park, 1974; Lee, 1980; Lee, 1996; Park and Hong, 2007).

The diagnostic features of *Bistorta* include perennial habit, stout and often contorted rhizome, simple stem, basal rosettes, revolute leaf margin with broad nerves on the edges, cylindrical and oblique ochreae, spike-like cyme with dense flowers, five-parted perianth, eight stamens, fusion of nectaries with the base of the inner stamens to form a disc, and tricolpate pollens (Greene, 1904; Gross 1913b; Hedberg, 1946; Haraldson, 1978; Ronse Decrane and Akeroyd, 1988). Phylogenetic analyses of DNA sequence data strongly support *Bistorta* as being monophyletic (Kim and Donoghue, 2008; Sanchez et al., 2011).

Among the species of *Bistorta*, *B. officinalis* Delarbre is cultivated in Europe for ornamental purposes due to its beautiful flowers (Cullen et al., 2011).

The dried roots of *B. officinalis* have been widely used as Chinese folk medicine for the treatment of suppurative dermatitis, hemorrhoids, and hematemesis (PPRC, 2000). In Korea, the roots and rhizome of *B. manshuriensis* Kom. have been used as a medicinal herb to cure fever and diarrhea (Lim, 1961; NPRI, 1998). The species of *Bistorta* contain a variety of medicinally important flavonoids such as rutin, quercetin, myricetin, and kaempferol (Chang et al. 2009; Vysochina and Voronkova, 2013) indicating their potential commercial value as natural product resources for drug development.

The taxonomy of *Bistorta* is largely based on a combination of several morphological features such as habit, shape and size of rhizome, shape and size of the basal (radical) leaves, length of petiole, presence or absence of petiole wing, leaf pubescence, attachment of cauline leaves, bract shape, and shape and color of the perianth (Meisner, 1856; Petrov, 1928; Komarov, 1926, 1936; Nakai, 1938; Li et al., 2003; Yonekura, 2006; Park and Hong, 2007). *Bistorta*, however, is a taxonomically difficult group presenting confusion over the identity and circumscription of species, and the relationships among the species. In particular, *Bistorta* has: 1) few useful morphological characteristics to reflect affinity among the species, 2) complex pattern of variation due to overlapping distinguishing characters between populations, 3) geographically specific characters, 4) differences in the selection of characters and interpretations depending on the opinion of the author, and 5) lack of molecular phylogenetic studies to address phylogenetic relationships within *Bistorta*.

One prominent species complex within *Bistorta*, the *B. manshuriensis* complex includes closely related and controversial taxa distributed predominantly in northeast Asia. These include *B. manshuriensis* (Petrov ex Kom.) Kom. ex Nakai, *B. pacifica* (Petrov ex Kom.) Kom. ex Nakai and *B. alopecuroides* (Turcz. ex Besser) Kom. and two taxa from Japan supposed to be closely related; *B. major* Gray var. *japonica* H. Hara and *B. major* Gray var. *ovata* (Nakai ex H. Hara) H. Hara. The complex was previously circumscribed in series *Bistorta* (Komarov, 1936) or section *Bistorta* (Petrov, 1928; Tzvelev, 1987; Yonekura, 2006).

Bistorta manshuriensis was described by Komarov (1926) as *Polygonum manshuriense* Petrov ex. Kom. based on specimens collected in northern China (Manchuria) and the Khabarovsk region of the Russian Far East. It has been distinguished from closely related species by the presence of lanceolate or oblong basal leaves, cuneate leaf base and the presence of wings on the upper part of the petiole (Komarov, 1926, 1936). *Bistorta manshuriensis* is distributed in northeast China, Russian Far East and on the Korean peninsula (Komarov, 1926, 1936; Nakai, 1938: Li et al., 2003). Some Korean taxonomists, however, have not recognized this species as part of the Korean flora. Its distribution in Korea was first reported by Nakai (1938), who was followed by subsequent authors (Park, 1974; Lee, 1980, Park and Hong, 2007). However, Chung (1957) did not recognize *B. manshuriensis* as being in Korea. He was followed by Lee (1996), who recognized *B. major* var. *japonica* (≡ *B. officinalis* subsp. *japonica*), originally described from Japan, in Korea, and excluded *B. manshuriensis* from the Korean flora. In contrast, Lee (1996) considered both *B. manshuriensis* and *B. major* var. *japonica* to be in Korea.

Bistorta alopecuroides, described from Eastern Siberia near Lake Baikal, occurs in the Russian Far East, Mongolia, northeast China and disjunctively on Jeju Island, Korea (Komarov, 1926, 1936; Nakai, 1938: Li et al., 2003). *Bistorta* *alopecuroides* is distinguished from closely related species by its glabrous, narrower basal and cauline leaves with rounded or cuneate base, and decurrent petiole. Its occurrence in Korea has been controversial. It was first reported from Korea (Jeju Island) by Nakai (1938). Nakai's treatment was followed by subsequent authors ((Park, 1974; Lee, 1980, Park and Hong, 2007). In contrast, the individuals of *Bistorta* with narrow lanceolate leaves on Mt. Halla, Jeju Island, have been treated as *B. vulgaris* var. *angustifolia* (Hayne) H. Gross or *B. major* var. *angustifolia* (Gross) Y. Lee (Gross, 1913a; Lee, 1996). Recently, Yonekura reported *B. officinalis* subsp. *japonica* (H. Hara) Yonek. (Yonekura, 2006) from Mt. Halla, which has further complicated the taxonomic identity of the *Bistorta* populations occurring there.

Bistorta pacifica was described by Komarov (1926) as *Polygonum pacificum* (Petrov ex Kom.) Kom. on the basis of specimens collected from Russian Far East. *Bistorta pacifica* is distinguished from closely related taxa on the basis of thick, ovate, basal leaves, cordate leaf base; and long petiole with vestigial wing (Komarov, 1926). *Bistorta pacifica* is in northeast China, Korea and the Russian Far East. Kitagawa (1972) was the first to recognize infraspecific taxa when he segregated pubescent plants of northeast China and Korea as *B. pacifica* f. *velutina* Kitag. Forma *velutina* has not been recognized by subsequent authors except by Lee (1996).

Plants distributed in northern Japan that appear to be closely related to *B. pacifica* have been recognized as *B. major* var. *ovata* (Nakai ex H. Hara) H. Hara (Hara, 1937). *Bistorta major* var. *ovata* was distinguished from related taxa on the basis of its ovate leaves, long, winged petioles, subsessile middle cauline leaves, absence of hairs and dense spicate inflorescence (Hara, 1934). *Bistorta major* var. *ovata* is occurs from from Hokkaido to central Honshu. Yonekura (2006), however, combined *B. major* var. *ovata* with *B. pacifica* and treated it as a synonym of *B. officinalis* Delarbre subsp. *pacifica* (Petrov ex Kom.) Yonek.

A plant closely related to the *B. manshuriensis* complex, *Bistorta major* var. *japonica* was described from Honshu of Japan (Hara, 1952). The diagnostic characters of *B. major* var. *japonica* include erect habit and glabrous, lanceolate leaves gradually tapering towards the apex. *Bistorta major* var. *japonica* occurs from central Honshu to Kyushu (Yonekura, 2006).

The five taxa of the complex are quite similar to each other in morphology, with the taxa distinguished mainly on the basis of the shape and size of the basal leaves, base of the leaf blade, length of petiole, width of wing on the petiole, length of the ochreae, shape of the inflorescence, and color of the perianth (Komarov, 1936; Nakai, 1938; Park, 1974; Lee, 1980; Lee, 1996; Li et al., 2003; Yonekura, 2006; Park and Hong, 2007). However, because of considerable variation and some degree of overlap in most distinguishing characters, there are different views on boundaries and relationships regarding the delimitation of these taxa. The taxonomic identity, pattern of divergence, and taxonomic relationship between the closely related taxa of different geographic region is poorly understood. For example, the relationship between the populations in Korea identified as *B. manshuriensis* are morphologically similar to *B. officinalis* subsp. *japonica* of Japan. Despite strong morphological affinities, however, they have been treated as separate taxa and their relationship has not been well understood. In contrast, the Korean individuals identified as *B. manshuriensis* are morphologically distinct from plants of *B. manshuriensis* in northeast China and Russian Far East, yet they have not been recognized as a different taxon. Moreover, the plants on Mt. Halla and along the southern coast of the Korean peninsula identified as *B. alopecuroides* show a number of morphological differences, such as plant height, shape and size of the leaves and width of the petiole wing from plants of *B. alopecuroides* in Mongolia, northeast China and Russian Far East. In addition, the relationship between *B. pacifica* of Korea, northeast China and Russian Far East and *B. major* var. *ovata* in Japan has also been controversial (Miyabe and Kudo, 1934; Hara, 1937; Yonekura, 2006).

There have been a few previous phylogenetic analyses of Polygonaceae based on chloroplast and nuclear DNA sequences with little representation from the genus *Bistorta*. Most of these studies have revealed *Bistorta* to be a strongly supported monophyletic group sister to the *Koenigia-Aconogonum* clade, however, with inadequate sampling none of these studies addressed phylogenetic relationships within *Bistorta* (Kim and Donoghue, 2008; Galasso et al., 2009; Sanchez et al. 2011; Schuster et al. 2011). Not surprisingly, none of these phylogenetic studies have included samples from the *B. manshuriensis* complex.

Chromosome number has been found useful in delimiting species in many species complexes in plants (Bardy et al. 2011; Marcussen and Borgen, 2011). Few counts of chromosome are known in *Bistorta*. Löve & Löve (1974; 1975) reported counts of $2n = 48$ for *B. major* and $2n = 72$ for *B. plumosa*. Counts from the species of *Bistorta* suggested base chromosome number of $x = 11, 12$ (Löve & Löve (1974; Karlsson, 2000; Freeman & Hinds, 2005). Diploids, tetraploids, hypotetraploids ($2n = 44, 46$) and hypertetraploids ($2n = 50$) have been reported in *Bistorta* (Doida, 1960; Löve, 1954; Löve & Löve, 1974; Goldblatt, 1988; Krogulevich & Rostovtseva, 1984; Krahulková, 1990). Among the taxa of the *B. manshuriensis* complex, *B. major* var. *ovata* has been reported to be tetraploid (2*n* = 4x = 48) and *B. major* var. *japonica* as both diploid (2*n* = 2x = 24) and tetraploid (Yonekura, 2006). The chromosome numbers of *B. manshuriensis* and *B. alopecuroides* is unknown.

Considering the variation in morphology and confusions in the circumscription of species in the *B. manshuriensis* complex, this study was carried out; 1) to clarify the taxonomic identities of the members of the *B. manshuriensis* complex based on morphological, cytological and molecular analyses, 2) to evaluate the degree of morphological variation in each of the taxa of the *B. manshuriensis* complex, 3) to infer phylogenetic relationships among the species of the complex based on chloroplast and nuclear DNA sequences, and 4) to provide a taxonomic treatment of the taxa of the complex based on the results.

II. Materials and Methods

Taxon sampling: Analysis of gross morphological characters of the *B. manshuriensis* complex and related species for this study was carried out by examining over 1300 separate specimens (i. e. not including duplicates) including type specimens. About 700 individuals were collected from Korea, Russia, Mongolia, China and Japan from 2007 to 2016. The specimens are deposited in the herbarium of Seoul National University (SNU). Type specimens and general collections were examined from National Institute of Biological Resources (KB), Kangwon National University herbarium (KNU), Warm-Temperate and Subtropical Forest Research Center, Korea (WTFRC), Komarov Botanical Institute (LE), University of Tokyo (TI), National Museum of Nature and Science, Tsukuba (TNS) and Harvard University Herbarium (HUH). Type specimens of nearly all names were studied, mostly through direct examination, or occasionally through online image databases or physical photographic images. All descriptions are based on herbarium specimens and field observations.

External morphology: In the present study, ca. 250 specimens covering all taxa of the complex and related taxa collected directly from field in Korea, China, Russia and Japan were analyzed. One hundred and fifty different specimens were used for numerical analyses.

Based on the type specimens and original descriptions, the diagnostic characters were identified, measured and analyzed. All measurements were based on herbarium specimens. Reproductive parts were rehydrated by putting in water at

60°C for 1 min prior to dissection. To avoid spatial variations, the same location on every plant was selected for measurement. Informations about distribution, habit, habitat, vernacular names, flowering, and fruiting periods were derived from herbarium specimen label data in combination with field observations. Herbarium specimen data were also used to verify consistency in characters. Fruit color was stated for mature fruits. Flowers and fruits were measured by using micrometer in dissecting microscope.

Anatomical study: To elucidate the differences on epidermal characteristics such as trichome morphology and distribution, shape and size of stomata, and epicuticular wax, the fresh plant material was collected and fixed in FAA for at least 48 hours. The fixed material was washed with distilled water and stored in 70% ethanol. For SEM observation, leaf samples were sectioned into small pieces ca. 0.5 x 0.5 cm with a razor blade. After dehydration in a graded ethanol and acetone series, the material was critical point dried with CO_2 using a Critical Point Drier (SPI 13200E-AB, SPI supplies, West Chester, PA, USA). The dried material was mounted onto aluminium stubs with double adhesive tape. Ion coater (Kressington Sputter Coater 108auto) was used for gold-coating for 45 sec in 40 mA and a low vacuum environment of 0.1 to 0.05 mbar. The above condition yielded in metal deposition of 1 nm/sl. Scanning Electron Microscope (JEOL JSM-6390LV) was used for observation and photographs at an acceleration voltage of 15kV.

Chromosome counts: Sixty-six accessions from 53 populations representing morphologically distinct groups of all taxa of the *B. manshuriensis* complex and the two closely related taxa from Japan were included in the chromosome counts. Chromosome counts were determined from root tip meristems. Individuals transplanted from the field to the greenhouse at Seoul National University were sampled for chromosomal study. In some cases, root tips directly collected from the field were used for chromosomal study. Root tips were pretreated in a solution of 0.1% colchicine (w/v) for 3–4 hours at room temperature and fixed in acetic alcohol (glacial acetic acid: absolute alcohol 1:3 v/v) for 30 min and macerated for 8 min in 1N HCl at 60°C. After washing in distilled water, root tips were stained for 30 min in 1.5% synthetic acetic orcein and squashed using the procedure of Darlington and LaCour (1976). Chromosome preparations were observed and photographed with an Olympus-BX50 microscope at 800–2000x. Voucher specimens are deposited in the herbarium of Seoul National University (SNU).

Principal Component Analysis (PCA): The data matrix for numerical analysis was obtained by considering each herbarium specimen as an OTU. Seventeen useful morphological characters were observed and measured. Table 1 shows the classes of quantitative characters adopted in the present study. Characters were standardized, so that each variable had a zero mean and a unit standard deviation.

In order to verify which of the variables account for most of the variation among groups and which characters are the most important in discriminating among species, PCA was applied for a complete data set containing all three taxa of the complex and related taxa. PCA was performed in microcomputer using SAS program (SAS Institute, 2011: Release 9.3), the correlation matrix was calculated and analyzed.

Table 1. Morphological characters selected for the principal component analysis (PCA) of the *B. manshuriensis* complex and related species

Leaf (basal leaf)

1. Leaf blade length (cm)
2. Leaf blade width at the widest point (cm)
3. Distance from leaf apex to the widest point of leaf (cm)
4. Leaf apex angle/2
5. Leaf base angle/2
6. Character 2/character 1
7. Blade width at 1/3 point of blade
8. Blade width at 1/2 point of blade
9. Blade width at 2/3 point of blade
10. Petiole length (cm)
11. Length of petiole wing (cm)
12. Width of petiole wing at 1/2 point of wing (cm)
13. Character 10/character1

Ochrea and leaf sheath

14. Ochrea length (cm)
15. Leaf sheath length (cm)
16. Character 15/character 14

Inflorescence

17. Inflorescence length (cm)

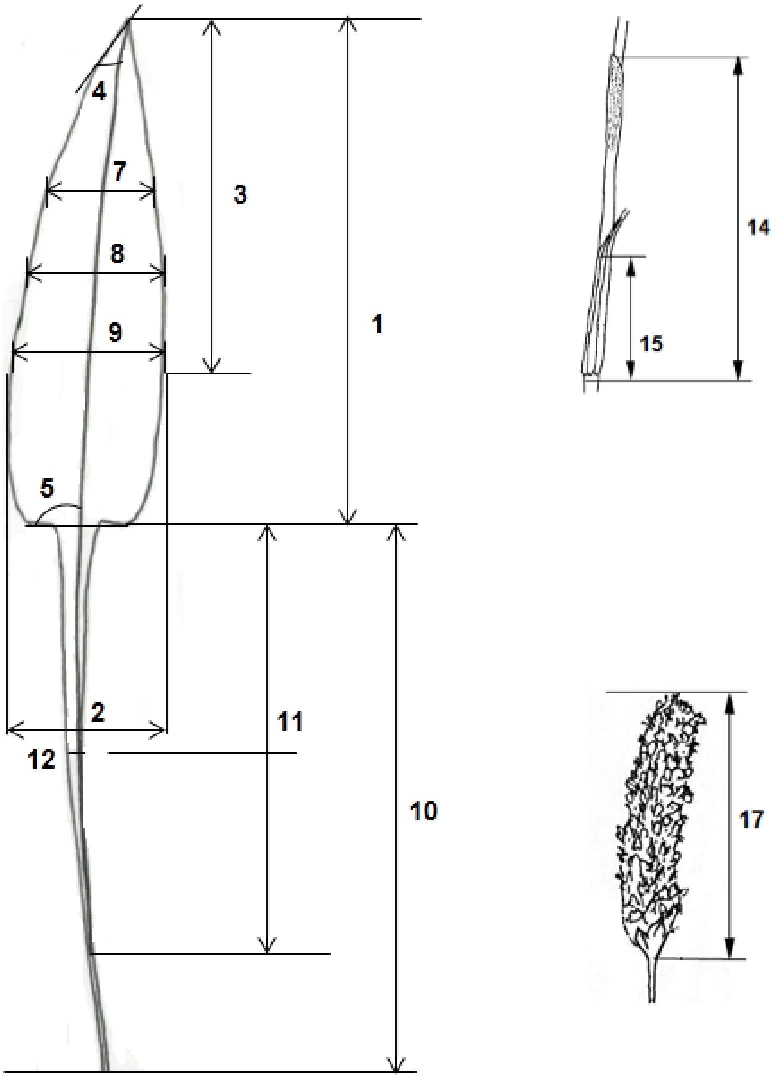

Fig. 1. Diagram showing characters measured for numerical analysis of the *B. manshuriensis* complex in northeast Asia. Numbers correspond to character numbers in Table 1.

Population sampling for molecular study: Fresh or silica-dried leaf materials of 182 accessions representing all three taxa of the *Bistorta manshuriensis* complex and two related taxa as well as two outgroup taxa were collected from 82 natural populations in northeast China, Japan, Korea, Mongolia and Russian Far East (Table 2). For the majority of taxa, two or more accessions from each population were analyzed. Two accessions of *B. suffulta* and one accession of *B. amplexicaulis* were selected as outgroup for molecular analysis. Voucher information, herbaria, and GenBank accession numbers of all species and sequences used in the molecular study are listed in Table 2. Voucher specimens of all accessions are deposited in SNU.

DNA extraction, PCR amplification, and sequencing: Genomic DNA from fresh or silica-dried leaf materials was extracted using DNeasy plant mini kit (Qiagen, Germany). Extracted DNA was separated on 1% agarose gel with ethidium bromide and quantified either by visual comparison of band intensities compared to standard size marker (*lambda* DNA cut with a double digest of *Hind*III and *Eco*RI) or through the use of NanoDrop 1000 Spectrophotometer (Thermo Scientific, Wilmington, DE 19810 U.S.A.). Sequences at different regions of genome evolve at different rates. Sequence data from two gene regions (*matK* and *ndhF*), two introns (*trnK* and *rpl16*) and two intergenic spacers (*psbA-trnH* and *rbcL-accD*) of cpDNA, and nuclear rDNA ITS were determined and analyzed in this study. Nuclear ITS and the six cpDNA regions, including *trnK* intron, *matK* gene, *psbA-trnH* IGS, *rpl16* intron, *ndhF* and *rbcL-accD* IGS, were amplified by polymerase chain reaction (PCR). Amplifications were conducted in 50 ul total volume reactions containing approximately 10–30 ng of genomic DNA. PCR was performed in GeneAmp PCR System 2400 (Perkin Elmer, Norwalk, Connecticut, USA) with standard protocol.

For the ITS region (ITS1, 5.8S, ITS2), ITS1 and ITS4 primers (White et al., 1990) were used. The PCR cycle profile comprised an initial step of 98°C (3 min), 35 cycles with 1 min denaturation at 95°C, 30 s annealing at 54°C, and 45 s extension at 72°C, and a final 7 min extension step at 72°C. The thermal conditions for *trnK* intron, *matK* gene, *rpl16* intron and *ndhF* gene was as follows: an initial denaturation step at 95°C for 3 min, followed by 35 cycles of 1 min denaturation at 95°C, 30 s annealing at 51–52°C and 75 s extension at 72°C, and a final extension step at 72°C for 7 min. The thermal conditions were similar for *psbA*-*trn*H IGS and *rbcL-accD* IGS regions except that the annealing temperature was 55°C for *psbA-trnH* IGS and 50°C for *rbcL-accD* IGS and extension time was 45 s in both. The primer pairs used to amplify all six cpDNA sequence regions examined are listed in Table 3.

The PCR products were visualized (checked) on 1% agarose gel and successful amplifications were cleaned by 1-hour digestion at 37°C with 2 units of exonuclease I and 2 units of SAP (Affymetrix, Ohio, USA) following the procedure of Werle et al. (1994). Cycle sequencing reactions were performed for the purified PCR products using BigDye Terminator Cycle Sequencing Ready Reaction Kit (ver 3.1, Applied Biosystems, Foster City, CA, USA) following the manufacturer’s instructions. Sequencing primers used were identical to the amplification primers. However, an additional internal sequencing primer was used for sequencing in *matK*. The sequencing reaction conditions were as follows: 94°C for 1 min;

followed by 25 cycles of 96°C for 10 s, 50°C for 5 s, and 60°C for 4 min; and subsequent storage at 4°C. Sequencing reactions were purified through ethanol/sodium acetate precipitation method, air-dried and sent to the DNA Sequencing Facility at Seoul National University or Macrogen, Korea where gels were run using an ABI 3730 DNA analyzer (Applied Biosystems, CA, USA).

DNA Data Analysis: Forward and reverse sequence reads were edited and assembled into contigs in Sequencher 5.1 (Gene Codes Corp., Ann Arbor, Michigan). Alignment was straightforward for *trnK* intron, *matK* gene and *ndhF* gene across the taxa of the complex but the introns (*trnK* and *rpl16*) and the spacers (*psbA-trnH* IGS and *rbcL-accD* IGS) showed length variablility. Sequences were initially aligned in Clustal X version 1.81 using default alignment parameters (Thompson et al., 1997). The resulting alignments were checked and refined manually Se-Al ver. 2.0a11 (Rambout, 2002) to optimize homology. Alignment gaps were treated as missing data. Each indel was considered to have originated independently. A 180 bp region in *psbA-trnH* consisting of microsatellite motif variations and tandem repeats couldn’t be aligned unambiguously and hence, excluded from the analysis. One inversion was inferred in the *psbA-trnH* IGS: a 30-bp stretch between positions 1870–1899 in some accessions identified as *B. manshuriensis* and *B. alopecuroides*. The inversion was reverse complemented in the alignment to reflect the ancestral orientation and included in the analyses (Graham et al., 2000; Lohne and Borsch, 2005; Ochoterena, 2009; Davis and Soreng, 2010; Cohen and Davis, 2012).

Table 2. Population code, locality, collection number, number of individuals investigated and haplotypes observed for 182 accessions of the *B. manshuriensis* complex and closely related taxa examined in this study (outgroup taxa included). All vouchers are deposited in SNU. Specific localities of the accessions sampled from northeast China, Japan, Korea, Mongolia, and Russian Far East are shown in Fig. 2. Asterisk indicates population-specific haplotype.

Population code	**Locality and collection number**	**No. of individuals**
B. manshuriensis		
M1	RUSSIA. Khabarovsk Krai, Sovetscaya, *Komarov 64*	1
M2	RUSSIA. Primorsky, Khankaysky District, vicinities of Tury Rog village, near Khanka Lake, *Park et al. 114, 117, 118*	3
M3	RUSSIA. Primorsky, Khankaysky District, vicinities of Komissarovo settlement, *Park et al. 65–68, 70–72, 76, 80–92, 94, 95, 97–101, 103, 104*	30
M4	RUSSIA. Primorsky, Khankaysky District, vicinities of Ilyinka village, on the mixed meadow, *Park et al. 63*	1
M5	RUSSIA. Primorsky, near Olenevad, *Park & Choi 54*	1
M6	RUSSIA. Primorsky, Russia Island, *Park & Choi 32, 35*	2
M7	CHINA. Heilongjiang, *Bhandari & Choi 7*	1
M8	CHINA. Heilongjiang, *Bhandari & Choi 13-1, 39-1, Park & Choi 74*	3
M9	CHINA. Heilongjiang, *Bhandari & Choi 47*	1
M10	CHINA. Neimongol, *Lee 5*	1
M11	CHINA. Jilin, Ussulin, *Park & Choi 28*	1
M12	CHINA. Jilin, Sunburyeong, *Park & Choi 67, 72*	2

Table 2. (Continued).

Population code	**Locality and collection number**	**No. of individuals**
Korean accessions identified as *B. manshuriensis*		
M13	KOREA. Gangwon, Mt. Odae, Jingogae, *Bhandari 101*	1
M14	KOREA. Gangwon, Mt. Odae, Jilmaenuf, *Suh 15523, Bhandari 1562-1, -3*	3
M15	KOREA. Gangwon, Daegwanryeong, *Suh & Bhandari 15*	1
M16	KOREA. Gangwon, Mt. Daerung, *Bhandari & Kim 110903-52*	1
M17	KOREA. Kyeonggi-do, Mt. Suwon, *Bhandari 15717-2, -4*	2
M18	KOREA. Ganghwado, Mt. Hyeolgu, *Park & Kim 11072*	1
M19	KOREA. Kyeonggi-do, Gimpo-si, Mt. Gahyeon, *Bhandari 8031*	1
M20	KOREA. Kyeonggi-do, Namhansanseong, *Bhandari 12715-2, 16724-1*	2
M21	KOREA. Chungnam, Guraepo, *Bhandari 15714-18*	1
M22	KOREA. Chungnam, Manripo, *Bhandari 1105*	1
M23	KOREA. Chungnam, Seosan, Mt. Buchhun, *Suh & Bhandari 15714-5*	1
M24	KOREA. Chungnam, Mt. Oseo, *Bhandari 1573-1*	1
M25	KOREA. Chungnam, Mt. Oseo, *Bhandari 802, 808, 810, 815*	4
M26	KOREA. Chungbuk, Mt. Seondo, *Bhandari 1052*	1
M27	KOREA. Daegu, Gasansanseong, *Bhandari 7772, 7774*	2
M28	KOREA. Gyeongbuk, Mt. Biseul, *Bhandari 1001, 1002, 1010*	3
M29	KOREA. Gyeongnam, Mt. Jongnam, *Won 622*	1
M30	KOREA. Gyeongnam, Mt. Bulmo, *Park & Bhandari 5581, Won 579*	2

Table 2. (Continued).

Population code	Locality and collection number	No. of individuals
M31	KOREA. Gyeongnam, Mt. Jagul, *Bhandari 7754, 7762*	2
M32	KOREA. Gyeongnam, Mt. Mita, *Bhandari & Choi 127914*	1
M33	KOREA. Gwangju, Mt. Mudeong, *Bhandari 8055, 8057*	2
M34	KOREA. Jeollabuk, Mt. Duryun, *Bhandari 7022, 7030*	2
M35	KOREA. Jeonnam, Mt. Sammun, *Bhandari 7015, 7017*	2
B. pacifica		
P1	RUSSIA. Primorsky, Lazovsky District, near the marine biological station (Zapovednoye), *Doudkin 1–4*	4
P2	RUSSIA. Primorsky, Nakhodka, *Park et al. 12, 17*	2
P3	RUSSIA, Primorsky, *Park et al. 120624_4*	1
P4	RUSSIA. Primorsky, *Park et al. 94, 98*	2
P5	RUSSIA. Primorsky, Shkotovsky District, vicinities of Rechitsa village, *Park et al. 1–3*	3
P6	RUSSIA. Primorsky, Shkotovsky District, vicinities of Rechitsa village, *Park et al. 5–9*	5
P7	RUSSIA. Primorsky, Ussurisky, *Park & Choi 107, 108*	2
P8	RUSSIA, Primorsky, *Park et al. 120625_38-2*	1
P9	RUSSIA, Primorsky, *Park et al. 120625_1-4*	1
P10	CHINA. Jilin, *Choi 10, 11*	2
P11	CHINA. Jilin, *Choi 27, 30*	2
P12	CHINA. Jilin, Sunburyeong, *Park & Choi 53, Lee 2*	2
P13	CHINA. Jilin, *Oh et al. 145, 148*	2

Table 2. (Continued).

Population code	**Locality and collection number**	**No. of individuals**
P14	KOREA. Gyeonggi, Mt. Hwaak, *Bhandari 202, 205*	2
P15	KOREA. Gangwon, Inje, Mt. Daeam, *Suh & Bhandari 823-6, 823-10, Suh 1584-7*	3
P16	KOREA. Gangwon, Mt. Seorak, *Won & Bhandari 401–404, Bhandari 16621-1, 4, 6, 15*	8
P17	KOREA. Gangwon, Mt. Sowhangbyeong, *Bhandari & Suh 628-4*	1
P18	KOREA. Gangwon, Mt. Gyebang, *Bhandari 12724-09,11*	2
P19	KOREA. Gangwon, Mt. Gariwang, *Bhandari 151, 157, 169*	3
P20	KOREA. Gangwon, Mt. Cheongok, *Lee 650*; *Bhandari 1403*	2
P21	KOREA. Gangwon, Hongcheon, *Suh 1571-1*	1
P22	KOREA. Gangwon, Mt. Hambaek, *Bhandari 7079*	1
P23	KOREA. Gangwon, Mt. Hambaek, *Bhandari 7086*	1
P24	KOREA. Gangwon, Mt. Hambaek, Manhangje, *Suh 1575-1*	1
P25	KOREA. Gangwon, Mt. Taebaek, *Bhandari 702, 703*	2
P26	KOREA. Gangwon, Mt. Taebaek, *Bhandari 704*	1
P27	KOREA. Chungbuk, Mt. Sobaek, *Bhandari 4, 9, 15,40,53, 55*	6
P28	KOREA. Gyeongbuk, Mt. Ilwol, *Bhandari 11726-7*	1
P29	KOREA. Chungbuk, Mt. Minjuji, *Bhandari 1501, 1505*	2
P30	KOREA. Jeollabuk , Mt. Deokyu, *Bhandari 11103*	1
P31	KOREA. Jeollabuk, Mt. Jiri, *Bhandari 521*	1
P32	KOREA. Jeollabuk, Mt. Jiri, *Bhandari 532*	1

Table 2. (Continued).

Population code	**Locality and collection number**	**No. of individuals**
Korean populations identified as *B. alopecuroides*		
A1	KOREA. Gyeongnam, Mt. Gara, *Park & Bhandari 609, 6603*	2
A2	KOREA. Jeju, Ara, Samgakbong, *Bhandari & Kim 3106, 3108, Bhandari & Gao 3004*; *Won & Bhandari 330*	4
A3	KOREA. Jeju, Mt. Halla, Witseoreum, *Bhandari & Kim 3078, 3080, Kim 0904-1, 3*	4
A4	KOREA. Jeju, Mt. Halla, Yeongsil course, *Bhandari & Kim 3064*	1
A5	KOREA. Jeju, Mt. Halla, Baekrokdam, *Won & Bhandari B1, B3*, *B5*, *B7*	4
A6	KOREA. Jeju, Mt. Halla, Seongpanak course, *Bhandari 3013*	1
B. alopecuroides		
A7	MONGOLIA. Khentii, *Lee 1*	1
A8	MONGOLIA. Arkhangai, *Park & Kim B9*	1
B. major var. *major*		
B1	CHINA. Beijing, *Kwak 1*	1
B2	UK (transplanted at Royal Botanic Garden Edinburgh)	1
B. major var. *japonica*		
J1	JAPAN. Honshu, Nikko, *Park et al. 197*, *198*	2
J2	JAPAN. Kyushu, *Im 2*	1
J3	JAPAN	1
B. major var. *ovata*		
O1	JAPAN. Hokkaido, Rebun Island, *Suh 1*	1
O2	JAPAN. Hokkaido, Mt. Obira, *Kim 29–32*	4

Table 2. (Continued).

Population code	Locality and collection number	No. of individuals
B. amplexicaulis		
A1	CHINA. *Kim CY2001-084*	1
B. suffulta		
S1	KOREA. Jeju, Mt. Halla, *Won & Bhandari 321*	1
S2	KOREA. Jeju, Mt. Halla, *Bhandari 3391*	1

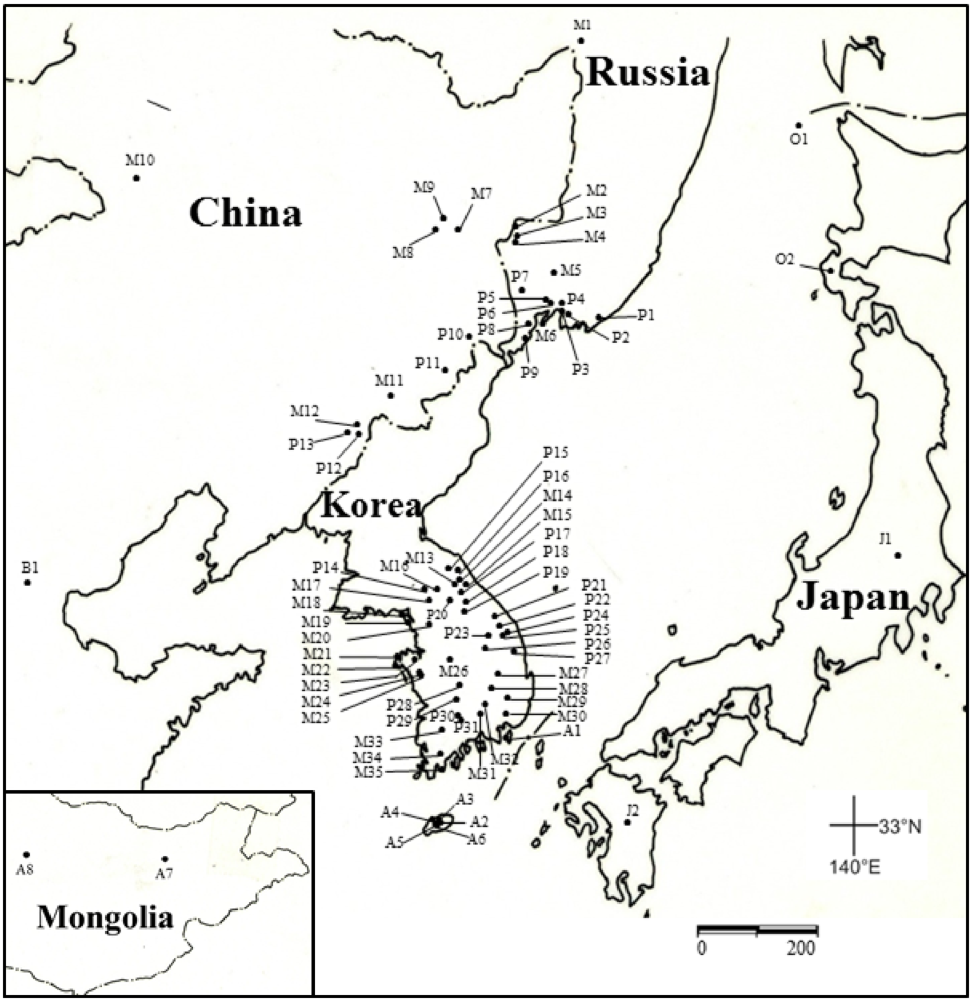

Fig. 2. Collection sites of the *B. manshuriensis* complex and related taxa used in this study. The population codes correspond to the population codes in Table 2.

Table 3. Primers used for PCR amplification and sequencing in this study. Primer names with asterisk (*) indicate primers used only for sequencing.

Region	Primers	Sequence (5’→3’)	Reference
Nuclear DNA			
ITS	ITSK1	TCGTAACAAGGTTTCCGTAGGT	Kim, pers. comm.
	ITS4	TCCTCCGCTTATTGATATGC	White et al. (1990)
Chloroplast DNA			
trnK	trnK3914F	GGGGTTGCTAACTCAACGG	Johnson & Soltis (1994)
	matk479R	ATGGATAGGGTGAGGTATC	Present study
matK	trnK670F	CTGTATCGCACTATGTATC	Kim (2007)
	matK1246R	CCGCTGTAATAATGAGAAAG	Kim (2007)
	matK193F*	GTTATTCGAATGTATCAACAG	Kim (2007)
	matK520R*	CTCATGCTTGCATTTATTACG	Kim (2007)
psbA-trnH	psbAF	GTTATGCATGAACGTAATGCTC	Sang et al. (1997)
	trnHR	CGCGCATGGTGGATTCACAATC	Sang et al. (1997)
rpl16	L16 exon1	AATAATCGCTATGCTTAGTG	Downie et al. (2000)
	L16 exon2	TCTTCCTCTATGTTGTTTACG	Downie et al. (2000)
ndhF	ndhF1F	ATGGAACAKACATATSAATATGCGTGG	Olmstead & Sweere (1994)
	ndhF1314R	GCGAAACATATAAAATGCTGTTAATCC	Present study
	ndhF7F	AGGTACACTTTCTCTTTCTGGTA	Olmstead & Sweere (1994)
	ndhF2110R	CTAYATATTTGATACCTTCTCC	Olmstead & Sweere (1994)
rbcL-accD	rbcL50F	GAAGTATGGAAGGAAATCA	Yasui & Ohnishi (1998)
	accD79R	ACAACATCGAATTAAACCAC	Kim (2007)

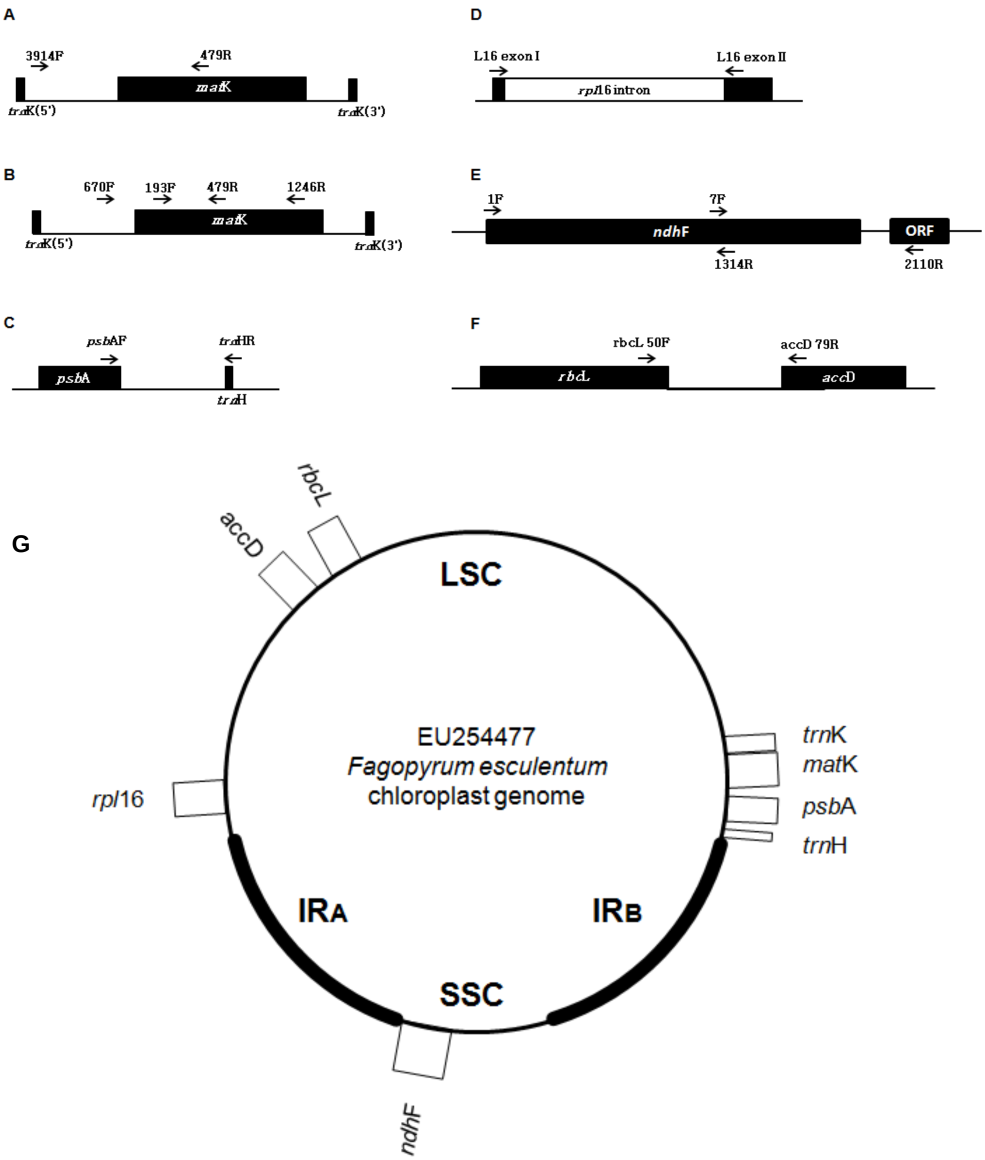

Fig. 3. The organization of six chloroplast regions (A–F) analyzed in this study and their positions in the chloroplast DNA (G) represented in the gene map of *Fagopyrum esculentum* genome (cf. Logacheva et al., 2008). Arrows indicate orientation and approximate position of primer sites used for PCR amplification and sequencing.

Phylogenetic analyses: Tree analyses were performed using PAUP 4.0b10 (Swofford, 2003). Nuclear ITS and cpDNA regions were analyzed separately. The six DNA regions were analyzed separately and also for combined data set. All characters were treated as unordered and weighted equally. Neighbor-Joining (NJ) analysis (Saitou and Nei, 1987) was employed to infer phylogenetic relationship.

The NJ tree was constructed using Kimura 2-parameter distance (Kimura, 1980). To search for the shortest trees, Maximum Parsimony (MP) analyses were performed using heuristic search with 100 replicates, random sequence addition with tree bisection and reconnection (TBR), holding 10 trees per replicate, MAXTREES set to no limit, ACCTRAN character optimization and MULTREES option in effect. Those shortest trees were used to generate a strict consensus tree. All characters were unweighted and unordered; positions containing insertions/deletions (indels) were excluded prior to all phylogenetic analyses. Consistency and retention indices were calculated in PAUP. Bootstrap (BS) analyses were performed to evaluated support for specific branches or clades (Felsenstein, 1985). BS values were calculated with 1,000 replicates under the same conditions with the exception that MAXTREES was set to 1,000. BS values 50% or above were reported.

Bayesian analyses were performed with MrBayes version 3.2 (Ronquist et al., 2012) with two simultaneous Markov Chain Monte Carlo (MCMC) runs of four chains. Substitution models for each gene were determined with mrmodeltest 2.3 (Nylander, 2004). One million generations were run with sampling every 100th generation and first 25% of trees discarded as burnin. The remaining trees were used to produce a 50% majority-rule consensus tree and determine posterior probabilities (PP). Analyses were run until the value of the average standard deviation of split frequencies dropped below 0.01.

Network Analysis: The combined data set of the three selected plastid regions (*trnK* intron, *matK* and *ndhF*) was also used for TCS network analysis using all informative sites. TCS was developed for population genetic data, where phylogenetic divergences are often low, ancestral haplotypes are typically extant, and multifurcations are common (Templeton et al., 1995; Posada and Crandall, 2001). In order to resolve haplotype relationships within the *B. manshuriensis* complex, a haplotype network was constructed by using TCS 1.21 (Clement et al., 2000). The 95% probability limit of parsimonious connections was applied to produce the network.

Table 4. List of acronyms representing localities in this study.

Acronym	**Locality**
bc	Mt. Buchhun
bj	Beijing
bl	Mt. Bulmo
bs	Mt. Biseol
ck	Mt. Cheong-ok
cn	China
dg	Daegwanryeong
dk	Mt. Deokyu
dm	Mt. Dae-am
dn	Mt. Duryun
dr	Mt. Daerung
gb	Mt. Gyebang
gn	Gasansanseong
gr	Mt. Gara
gy	Mt. Gahyeon
gu	Guraepo
gw	Mt. Gariwang
hb	Mt. Hambaek
hc	Hongcheon
hg	Mt. Hyeolgu
hj	Heilongjiang
hk	Hokkaido
hn	Honshu
hl	Mt. Halla
hw	Mt. Hwa-ak
il	Mt. Ilwol
jg	Mt. Jagul
jl	Jilin

Table 4. (Continued).

Acronym	Locality
Jm	Jilmaenuf
jn	Mt. Jongnam
jp	Japan
jr	Mt. Jiri
kb	Khabarovsk
kh	Khanka
kr	Korea
ky	Kyushu
mc	Mangcheoneo
md	Mt. Mudeong
mh	Manhangje
mj	Mt. Minjuji
mn	Mongolia
mp	Manripo
ms	Marine station
mt	Mt. Mita
nh	Namhansanseong
nm	Neimongol
nk	Nakhodka
od	Mt. Odae
os	Mt. Oseo
ot	Olenevad-Tikhoye
pr	Primorsky
rb	Rebun Island
rc	Rechitsa
ri	Russia Island
rs	Russia
sb	Seonburyeong
sh	Mt. Sohwangbyeong

Table 4. (Continued).

Acronym	Locality
sk	Mt. Seorak
sm	Mt. Sammun
sn	Mt. Seondo
so	Mt. Sobaek
sw	Mt. Suwon
tb	Mt. Tabebaek
uk	United Kingdom
ul	Ussulin
us	Ussurisky

III. Results

1. Morphology

The genus *Bistorta* is readily distinguished from other genera of Polygonaceae by its perennial habit, stout and often contorted rhizome, basal leaf-rosettes, revolute leaf margin with broad nerves on the edges, cylindrical and oblique ochrea, terminal or terminal and axillary spike-like cyme with dense flowers, five-parted perianth, eight free stamens, fusion of nectaries with the base of inner stamens, and tricolpate pollens (Greene, 1904; Gross 1913b; Hedberg, 1946; Haraldson, 1978; Ronse Decrane and Akeroyd, 1988).

Habit: Species of *Bistorta* are rhizomatous, herbaceous perennials or subshrubs that rarely attain more than 1.4 m in height. The species are erect, ascending, prostrate or creeping. The habit is one of the main basis for infrageneric classification by Petrov (1928). All taxa of the *B. manshuriensis* complex are erect, herbaceous perennials. Plant height usually ranges from 0.6—1.2 m at maturity. Plant height varies with the age of the plant as well as environmental conditions within and among the species of the complex. The plants growing in open grasslands are generally shorter than the plants growing under the forest. Habit appears to be of little taxonomic significance in distinguishing the taxa of the *B. manshuriensis* complex.

Rhizomes: The shape and size of rhizome provided one of the main basis for infrageneric classification in *Bistorta* by Petrov (1928) and Yonekura (2006). Three types of rhizomes have been described in *Bistorta*: 1) short, stout, unbranched, tortuous or rarely tuberous found (subgen. or sect. *Bistorta*), 2) cylindrical, moniliform and branched (subgen. *Bistortella* Petrov or sect. *Bistortella* (Petrov) Yonek.), and 3) thin, ligneous, branched and stoloniferous (subgen. *Pseudobistorta* Petrov). In the taxa of the *B. manshuriensis* complex, rhizomes are short, simple, stout, tortuous, non-torulose, and covered with fibrous remnants of radical leaves. Fibrous roots arise from the lower surface of the rhizome. The rhizome appears blackish outside and reddish brown inside. The size of rhizomes was variable across the taxa and populations in the complex. The rhizomes of *B. manshuriensis* individuals collected from northeast China as well as Olenevad and Russia Island of Russian Far East were the smallest in the complex with an average diam. of ca. 0.5 cm. The largest rhizomes were found in the individuals of *B. major* var. *ovata* with an average diam. of ca. 3 cm.

Stems: In *Bistorta*, the stems are mainly of two types– herbaceous and simple (subgen. *Bistorta* and subgen. *Bistortella* Petrov) or woody and branched (subgen. *Pseudobistorta* Petrov). The woody forms have black-brown bark in the stem. The stems are 1–4 mm in diam. In all taxa of the *B. manshuriensis* complex, stems are herbaceous, simple, erect, cylindrical, glabrous and pale green. The plants have hollow pith. The stems are 2–4 mm in diam. In an individual, the number of stems arising from rhizome varied from one to 10 in the complex. The number of stem was one to two in the *B. manshuriensis* from northeast China and Olenevad and Russia Island of Russian Far East, and eight to 10 in the individuals identified as *B. alopecuroides* collected from Mt. Gara of Korea. There were four to 10 nodes in a stem in the taxa of the *B. manshuriensis* complex. The number of nodes was presented as one of the key characters in series *Bistorta* by Komarov (1936).

However, the number of nodes in a stem varied across populations within species and even within populations and did not show any definitive pattern of variation in this study. Hence, number of nodes in a stem appears to be of little taxonomic significance.

Leaves: In *Bistorta*, basal (radical) leaves arise from rhizome. The basal leaves are rosulate, several to many, simple, ascending and long or short petiolate. The basal leaves are densely tufted in some species including *B. affinis*. The shape of the leaf blade can be linear, lanceolate, oblanceolate, elliptic or ovate. The shape of basal leaf blade showed considerable intraspecific variation, but was still regarded as the most important diagnostic character in *Bistorta* (Komarov, 1926, 1936; Nakai, 1938; Park, 1974; Lee, 1980; Lee, 1996; Yonekura, 2006; Park and Hong, 2007). In the members of the *B. manshuriensis* complex, the shape of leaf blade was linear, lanceolate or ovate. Basal leaves were absent in the individuals of *B. manshuriensis* of some populations of northeast China and Russian Far East. As these individuals had smallest rhizomes in the *B. manshuriensis* complex, the presence or absence of basal leaves appears to be correlated to the size of the rhizome. In the *B. manshuriensis* complex, length of basal leaf (character 1, Fig. 4) was 8.4–34.1 cm and maximum width (character 2, Fig. 4) was 0.60–12.9 cm. This large variation in leaf size appears to have resulted from variations in environmental conditions. The leaf blades of the Korean individuals identified as *B. manshuriensis* were 13.6–34.1 cm (averag 20.5 cm) long and 1.7–9.8 cm (average 5 cm) wide, representing longest basal leaves in the complex. In *B. pacifica*, the leaf blades were 9.5–21.2 cm (average 14.6 cm) long and 3.3–12.9 cm (average 6.5 cm) and in *B. major* var. *ovata* the blades were 13.1–18.4 cm (average 16.9 cm) long and 6.4–10.6 cm (average 9 cm) wide, indicating that these taxa had the wider leaves compared to other taxa of the complex. The leaf blades of Korean specimens identified as *B. alopecuroides* were 8.4–21.8 cm (average 14.2 cm) long and 0.6–3.6 cm (average 2 cm) wide and thus had narrower leaves than the other taxa of the complex. However, as there was wide variation in length and width of basal leaves within a species and these differences were overlapping among the taxa, these taxa were not revealed as taxonomically distinct on the basis of basal leaves.

The shape of the leaf blade of basal leaves varied from linear, lanceolate to ovate in the taxa of the *B. manshuriensis* complex. The width/length ratio of basal leaves was 0.05–0.23 (average 0.14) in the Korean individuals identified as *B. alopecuroides*, and this species was distinguished from other taxa of the complex by its linear to narrowly lanceolate basal leaves (Fig. 5). The width/length ratio of basal leaves was 0.09–0.44 (average 0.25) for *B. manshuriensis*. This species had lanceolate to narrowly ovate basal leaves and tend to have wider basal leaves than *B. alopecuroides*. The other two taxa, *B. pacifica* and *B. major* var. *ovata,* had narrowly ovate to widely ovate basal leaves with width/length ratio of 0.29–0.91 (average 0.45) for and 0.49–0.58 (average 0.53) respectively. The shape of basal leaves was similar in *B. pacifica* and *B. major* var. *ovata*. The leaf apex of basal leaf was acute or acuminate in the taxa of the complex. The leaf apex angle (half angle) of basal leaf varied from 3° to 53° in the individuals of the complex. *Bistorta alopecuroides* and *B. manshuriensis* tend to have acuminate leaf apex with the apex angle (half angle) varying from 3° to 26° (average 10) in *B. alopecuroides* and 6° to 35° (average 14.8°) in *B. manshuriensis*. *Bistorta pacifica* and *B. major* var. *ovata* tend to have acute leaf apex with the apex angle (half angle) varying from 19° to 41°

(average 32.8°) in *B. pacifica* and 7° to 53° (average 26.7°) in *B. major* var. *ovata*.

The base of the basal leaf blade was cuneate, rounded to truncate in the complex. The leaf base angle (half angle) varied from 10° to 172° in the *B. manshuriensis* complex. The leaf base of the Korean specimens identified as *B. alopecuroides* was cuneate to rounded with the base angle 13°–83° (average 48.4°). the leaf base was cuneate, truncate to subcordate in the Korean specimens identified as *B. manshuriensis* with the base angle ranging from 10°–120° (average 71.8°). In *B. pacifica* and *B. major* var. *ovata* the leaf base was cordate with the base angle ranging from 71°–172° (average 122.2°) and 90°–128° (average 106°) respectively.

The network of veins was raised and prominent in the abaxial leaf surface of *B. major* var. *ovata* as well as in some populations of *B. pacifica*. In contrast, the network of veins was not raised and less prominent in *B. manshuriensis* and *B. alopecuroides*. This character was used as an important diagnostic character to distinguish *B. pacifica* from other taxa of *Bistorta* (Komarov, 1926; 1936).

The leaf margin was entire in *B. alopecuroides* or strongly undulate in *B. major* var. *ovata*. The edge of the margin was generally revolute with thickened veins in the taxa of the complex. Veinlets were swollen, expanded, recurved and falcate at the margin of leaf blade. However, thickening of veinlets at the edge of the the leaf margin of *B. manshuriensis* collected from Russian Far East and northeast China, as well as the specimens collected from Mt. Odae of Korea was not prominent. Hence, the presence or absence of thickened veins at the leaf margin is useful in distinguishing some taxa of the complex. Basal leaves and lower cauline leaves usually had long petiole. The length of petiole ranged from 7.8 cm to 53 cm in the complex. Petioles were generally shorter in Korean individuals identified as *B. alopecuroides* compared to other taxa of the complex, ranging from 7.8-30.9 cm (average 16.7 cm). The length of petiole varied from 21.8 cm to 48 cm in *B. manshuriensis*, from 16.9 to 53 cm (average 33 cm) in *B. pacifica* and from 24.5 cm to 40 cm (average 33.6 cm) in *B. major* var. *ovata*. Thus, the average petiole length was nearly identical in *B. manshuriensis*, *B. pacifica* and *B. major* var. *japonica*.

The leaf blade of basal leaves are decurrent forming a wing-like outgrowths in upper part of petiole in most species of *Bistorta*. Presence or absence of petiole wing is useful in distinguishing some species in *Bistorta* (Komarov, 1936; Li et al. 2003; Yonekura, 2006). In all taxa of the *B. manshuriensis* complex, the upper part of petiole is winged. The length of wing in the petiole ranged from 1.4 cm to 24.8 cm in the complex. The wings were poorly developed in the Korean individuals of *B. pacifica* compared to Russian and Chinese individuals. The average width of petiole wing in ½ point of petiole wing was substantially lower in *B. pacifica* compared to other taxa of the complex (Fig. 6). Hence, the broadness of the wing in the petiole of basal appears to be useful to distinguish *B. pacifica* from other taxa of the complex. The petiole consisted of a well-developed cylindrical sheath at its base.

Cauline leaves were simple and alternate. Lower cauline leaves were petiolate with short leaf sheath at its base, and were disintegrating with age. The shape of leaf blade of lower cauline leaf and radical leaves was similar. Cauline leaves tend to be gradually smaller toward the upper part of the stem. Middle and upper cauline leaves were sessile, usually deeply amplexicaul, and with long cylindrical greenish sheath at the base. Middle leaves were ovate to lanceolate and the upper leaves were lanceolate or linear. The uppermost leaf was usually linear or filifom.

Pubescence of leaves: In *Bistorta*, the abaxial leaf surface is glabrous or pubescent. Pubescence of leaves has been used as a diagnostic character in distinguishing some species of *Bistorta* (Komarov, 1936; Nakai, 1938; Li et al. 2003; Park and Hong, 2007). The taxa of the *B. manshuriensis* complex had glabrous or pubescent basal leaves. Basal leaves were glabrous in all Russian and Chinese specimens of *B. manshuriensis* and most Korean specimens identified as *B. manshuriensis*. Individuals from three populations of Mt. Odae were found to have densely pubescent abaxial leaf surface. Basal leaves of all individuals of Chinese populations and a majority of Russian populations of *B. pacifica* were densely pubescent abaxially. In contrast, the leaves of Korean individuals of *B. pacifica* were generally glabrous. The individuals of *B. major* var. *ovata* were glabrous. The abaxial leaf surfaces of individuals of Mongolian population of *B. alopecuroides* were also densely pubescent. In contrast, Korean specimens identified as *B. alopecuroides* were generally glabrous. Thus, leaf pubescence appears to be a useful character in distinguishing some taxa of the complex.

Ochreae: In *Bistorta*, ochreae of cauline leaves are tubular, membranous, nerved, brown distally, green basally, and completely surrounding the nodes. The ochreae are easily lacerate, oblique, cleft to the middle or base, and eciliate at tips. In the the *B. manshuriensis* complex, the length of ochrea in lower cauline leaves ranged from 2.2–13.5 cm. Ochreae were cleft, but never to the base. Ochreae were generally glabrous in the complex. Ochreae of upper leaves were truncate apically. Ochrea of lowermost 1–2 cauline leaves disintegraded with age.

Inflorescences: In *Bistorta*, inflorescences are simple and usually terminal.

In some species, the inflorescences are terminal and axillary. The inflorescence consists of primary monochasia (helicoid cyme) arranged in spike-like secondary inflorescences. The monochasia arise from the node of spike. Each monochasium consists of 1–5 flowers, and is subtended by small brown bract. Each monochasium is surrounded by a pair of scarious and hyaline bracteoles. In some species including *B. vivipara*, the monochasia in the lower part of the inflorescence are replaced by bulbils. The number of flowers in the monochasia is an important diagnostic character (Yonekura, 2006). In the taxa of the *B. manshuriensis* complex, the number of flowers in each monochasium was 2–5. In *B. manshuriensis*, two or three flowers were found in each node. However, four flowers were found in each node in the individuals collected from populations in Gasansanseong, Mt. Mudeong and Mt. Buchhun of Korea, and five flowers were present in each node in the individuals collected from a population in Manripo of Korea. In the Korean individuals of *B. pacifica*, the number of flowers in each node was two or three. In contrast, in the Chinese and Russian individuals of *B. pacifica* as well as in *B. major* var. *ovata*, the number of flowers in each node was usually two. In *B. alopecuroides*, the number of flowers in each node was two or three. Thus, the number of flowers in each node was usually variable among populations within a species.

In *Bistorta*, the shape of the inflorescence is usually cylindrical and sometimes, globose. The shape of the inflorescence is a useful diagnostic character in distinguishing *B. globispica* from other species of *Bistorta* (Nakai, 1938; Park and Hong, 2007). In all taxa of the *B. manshuriensis* complex, the inflorescence was cylindrical with the length varying from 1.7 cm to 11.8 cm. Among the taxa of the complex, B. *alopecuroides* had shortest infloresecence (average 4.26 cm) and *B. major* var. *ovata* had the longest inflorescence (average 7.25 cm) (Character 17, Fig. 4). The inflorescence was simple, usually terminal, and consisted of a series of helicoid cymes (monochasia) arranged closely and compactly in dense spikes. Bracts were ovate to broadly elliptic with conspicuous mid-veins and cuspidate to acuminate apices. The shape of bract was one of the main characters used by Komarov (1936) for distinguishing some species of *Bistorta*. However, the shape and size of bracts was variable among the populations of a species in the taxa of *B. manshuriensis* complex and showed little taxonomic significance.

Flowers: Flowers bloom mostly from May to August. In *Bistorta*, the flowers are generally hermaphroditic with variable number of parts. Each flower is articulated at the base of the perianth with pedicel. Perianth is five-parted and nonaccrescent in fruit. The number of stamens is eight with flattened filament. The style is three-parted correlated with trigonous achene. The number of flower parts was found to be a constant character in the *B. manshuriensis* complex, with the number of tepals, stamens and styles five, eight and three respectively in all members. The color of the perianth was white, pink to purplish pink in the taxa of the complex. The color of the tepal is another important diagnostic character in *Bistorta* (Tzvelev, 1989). However, the color of the perianth was highly variable among the populations of a species and in some cases within the populations. Tepals were glabrous, obong, nerved, obtuse at the apex and slightly fused at the base. Tepals had the same trifid vasculature in all taxa of the complex consistent with Ronse Decraene and Akeroyd (1988). Stamens were exserted and arranged at the base of the perianth in two whorls, alternating with small glandular nectaries.

Filaments were glabrous, white and flattened. The anthers were pale purple to pink. Nectaries were pale reddish purple in color and the inner nectaries were fused with the filament bases. The styles were 3-cleft, connate at base and were strongly exserted from the perianth. The stigmas were minutely capitate in all members of the complex.

Achenes: In *Bistorta*, like all other genera of Polygonaceae, the fruits are achenes of basically trigonous shape. In the taxa of the *B. manshuriensis* complex, the trigonous achenes, with ovate or elliptic outline, were enclosed in the perianth or slightly exserted. The color of the achene was brown, dark brown to black. Stipe was absent but the beak was well developed. The achene surface was smooth and shiny with tessellated cell outline consistent with the previous results (Ronse Decrane et al., 2000). The anticlinal walls were collapsed and undulating (Fig. 7). The achenes of *B. major* var. *ovata* were approximately 3.6 x 2.2 mm and were largest in the complex (Table 5). The achenes of *B. pacifica* were slightly smaller with average size of 3.4 x 2 mm. Meanwhile, the average seed size of Korean and Russian individuals identified as *B. manshuriensis* were similar to the Korean individuals identified as *B. alopecuroides* (2.9 x 1.9 mm vs. 3 x 1.9 mm). The results indicated that seed size is a useful taxonomic character in distinguishing some taxa of the *B. manshuriensis* complex.

Leaf stomata and microstructure of epidermal cells: Stomatal density and size of the taxa of the complex are shown in Table 6. Stomata are generally distributed on abaxial leaf surface (Table 6; Fig. 8). Stomata were rare or absent on adaxial leaf surface (Table 6). Both anisocytic and anomocytic type of stomatal complex were found on the abaxial leaf surface in all taxa. However, anisocytic stomata were found in remarkably higher proportion. In the samples identified as *B. manshuriensis,* average stomatal density on abaxial surface ranged from 99.5 to 231.4 mm^{-2}. In *B. pacifica*, the average stomatal densisty on abaxial surface ranged from 82.2 to 447.7 mm^{-2}. In the samples identified as *B. alopecuroides, B. major* var. *ovata* and *B. major* var. *japonica* the average stomatal density on abaxial surface was 482.2, 199 and 23.6 mm^{-2} respectively (Table 6). Thus, stomatal density was variable among different taxa and populations. The density of stomata per 1 mm^2 was highest in an accession identified as *B. alopecuroides* and lowest in *B. pacifica* (Table 6). The average size of stomata including guard cells on abaxial surface was 18.8–27.5 x 9.3–19.3 µm in the complex (Fig. 8). The average size of stomata on abaxial surface of *B. manshuriensis* was 19.6–25.2 x 12.2–19.3 µm. The average size was 20.2–27.5 x 10.69–14.6 µm in *B. pacifica* and 18.1–18.3 x 9.3–11.2 µm in the sample identified as *B. alopecuroides*. Meanwhile, the average size of the stomata was 22.4 x 14.6 µm in *B. major* var. *ovata,* and 24.4 x 12.6 µm in *B. major* var. *japonica* (Table 6, Fig. 8).

In the *B. manshuriensis* complex, the shape and size of adaxial epidermal cells was basically same. Stomatal size was consistently larger on the adaxial than on the abaxial surface of the leaf across the taxa. The adaxial epidermal cells were polygonal with straight anticlinal walls. The size of the adaxial epidermal cells was 22.6–40.8 x 12.1–21.44 µm. The surface was covered with epicuticular wax (Fig. 8). Notably, epicuticular wax on the adaxial leaf surface was slightly variable among the taxa and among the population of the same taxon.

The epicuticular wax of Russian and the Korean samples identified as *B. manshuriensis*, except the sample of Mt. Odae, was thick and dense (Fig. 8).

Epicuticular wax in the individuals of Mt. Odae was weakly developed. Meanwhile, epicuticular wax was weakly developed on abaxial surface in *B. major* var. *ovata* and *B. major* var. *japonica* (Fig. 8). The size of the abaxial epidermal cells with partially linearized and irregular anticlinal walls was 47.6–77.3 x 23.8–29.7 μm in the complex. The epicuticular wax of abaxial leaf surface in the sample identified as *B. manshuriensis* is well developed (Fig. 8) compared to the sample of *B. pacifica* and the sample identified as *B. alopecuroides*. However, the epicuticular wax on the abaxial leaf surface of the individuals of Mt. Odae populations was weakly developed. The epicuticular wax on abaxial leaf surface was poorly developed in *B. major* var. *ovata* but strongly developed in *B. major* var. *japonica*. Thus, on the basis of variation in epicuticular wax characteristics, the latter two taxa could be clealy distinguished (Fig. 8).

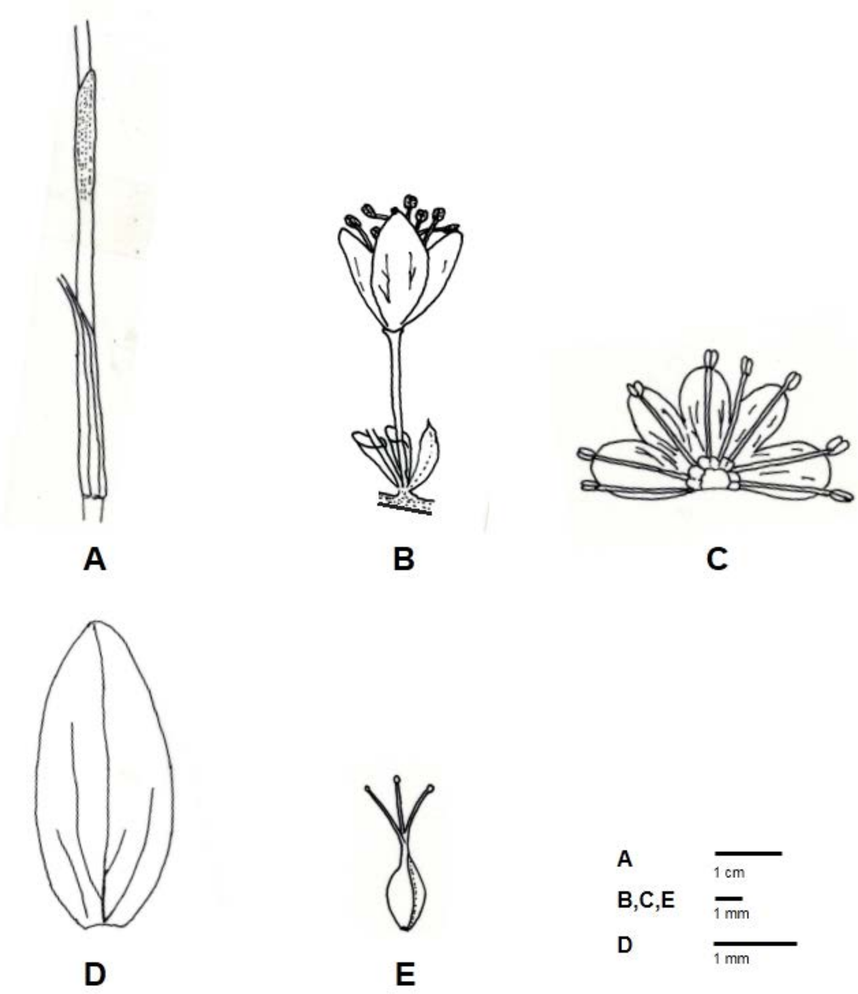

Fig. 4. Diagrams showing vegetative and reproductive parts in the *B. manshuriensis* complex. A. Leaf sheath and ochrea; B. A flower; C; A flower with tepals and stamens; D. A tepal; E. A pistil.

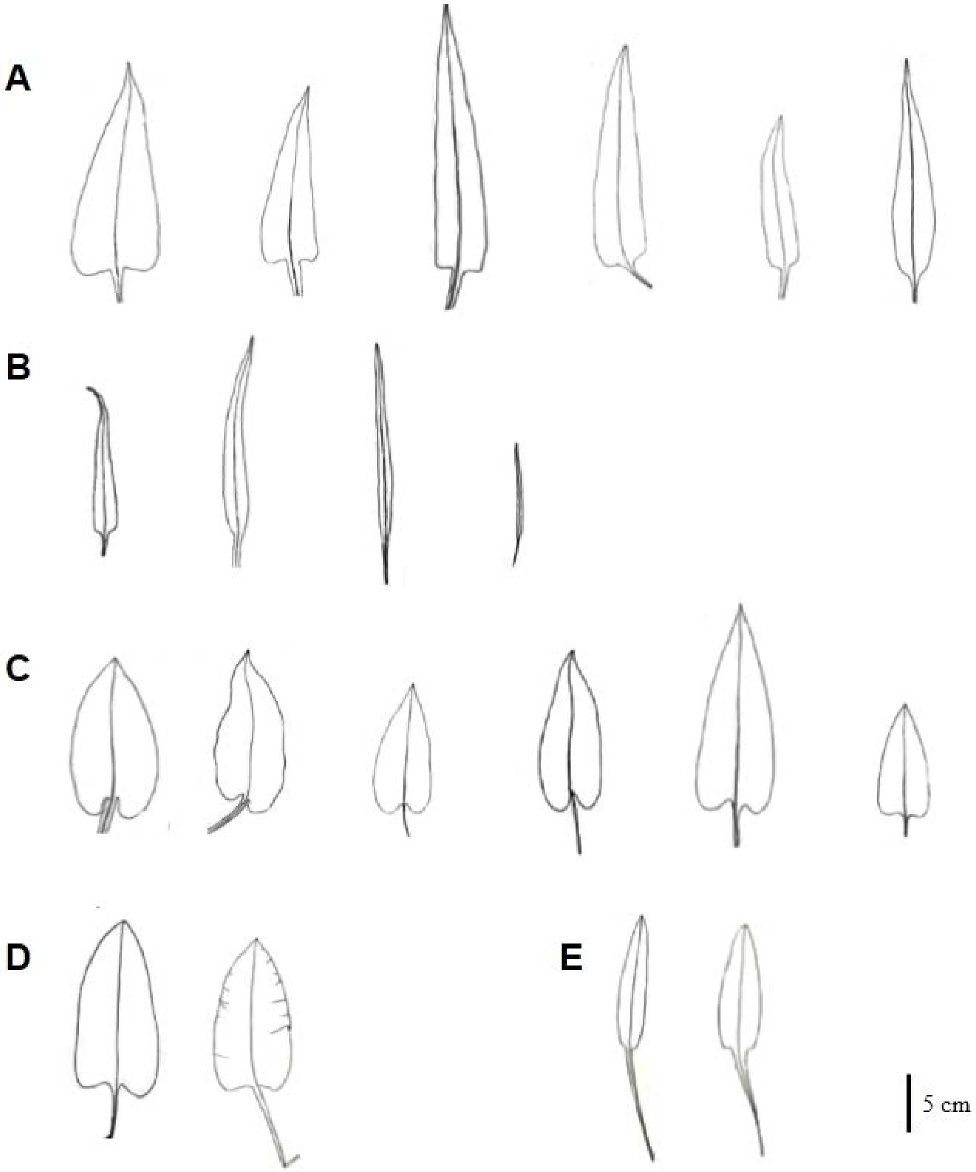

Fig. 5. Variation in leaf shape and size in the *B. manshuriensis* complex. A, Korean individuals identified as *B. manshuriensis;* B, Korean individuals identified as *B. alopecuroides*; C, *B. pacifica*; D, *B. major* var. *ovata*; E, *B. major* var. *japonica*.

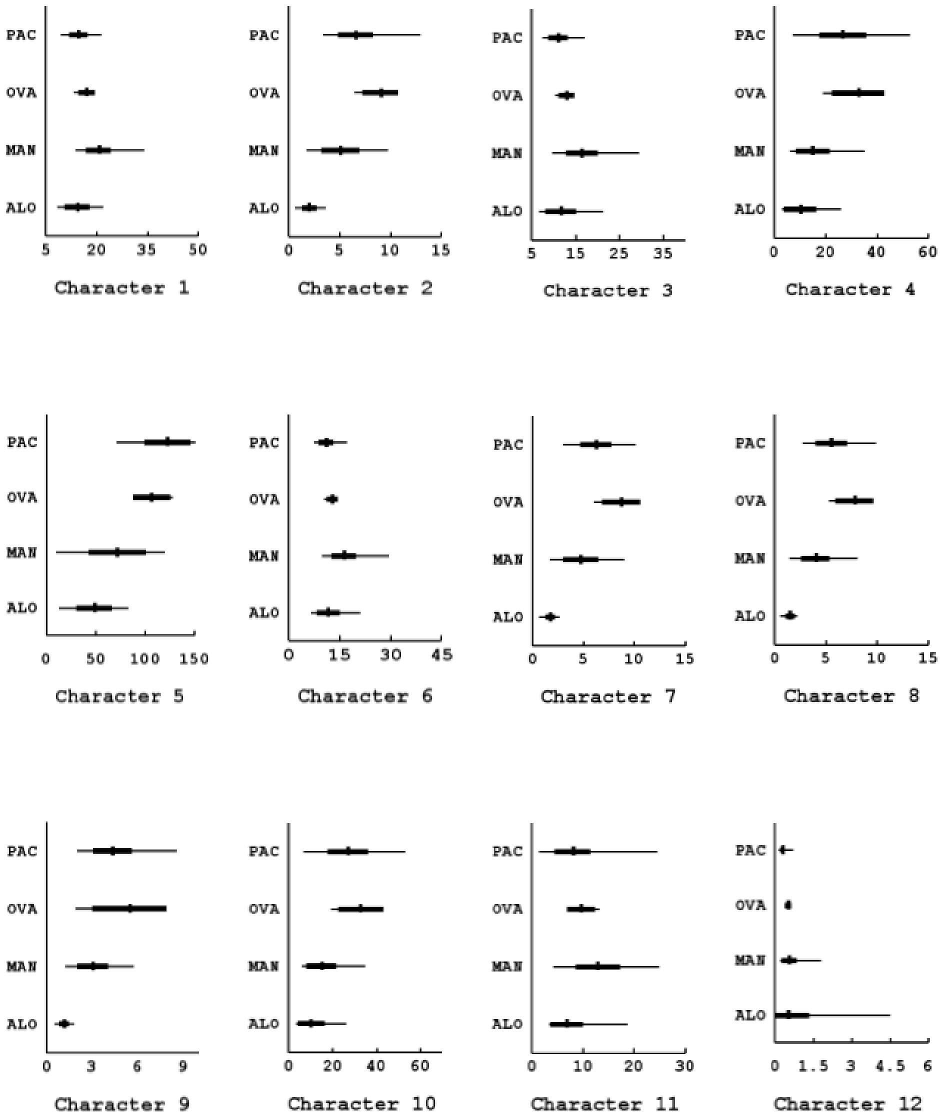

Fig. 6. Means, ranges and standard deviations of 17 morphological characters measured from individuals of the *B. manshureiensis* complex. Character numbers correspond to those in Table 1 and Fig. 1. PAC: *B. pacifica*, OVA: *B. major* var. *ovata*, MAN: *B. manshuriensis*, ALO: *B. alopecuroides.*

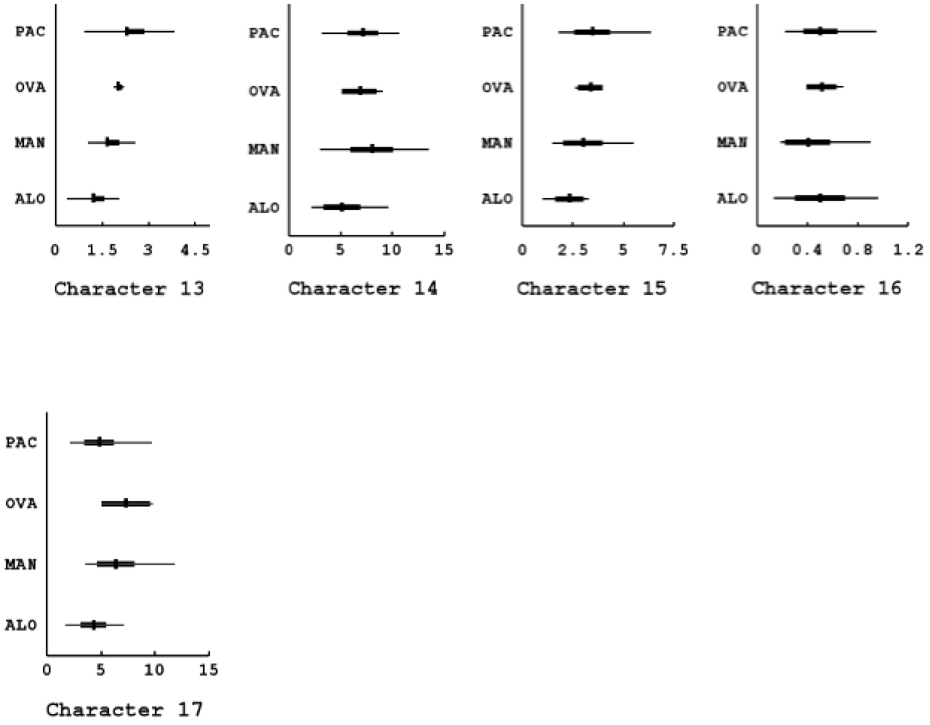

Fig. 6. (Continued)

Table 5. Size of achenes of the taxa of the *B. manshuriensis* complex.

Taxon	Length (mm)			Width (mm)			W/L
	Min.	Max.	Mean	Min.	Max.	Mean	
B. manshuriensis	2.4	3.4	2.9	1.5	2.6	1.9	0.66
B. pacifica	2.9	4	3.4	1.5	2.6	2	0.59
B. major var. *ovata*	3.2	3.9	3.6	1.9	2.5	2.2	0.61
B. alopecuroides	2.7	3.5	3	1.5	2.7	1.9	0.63

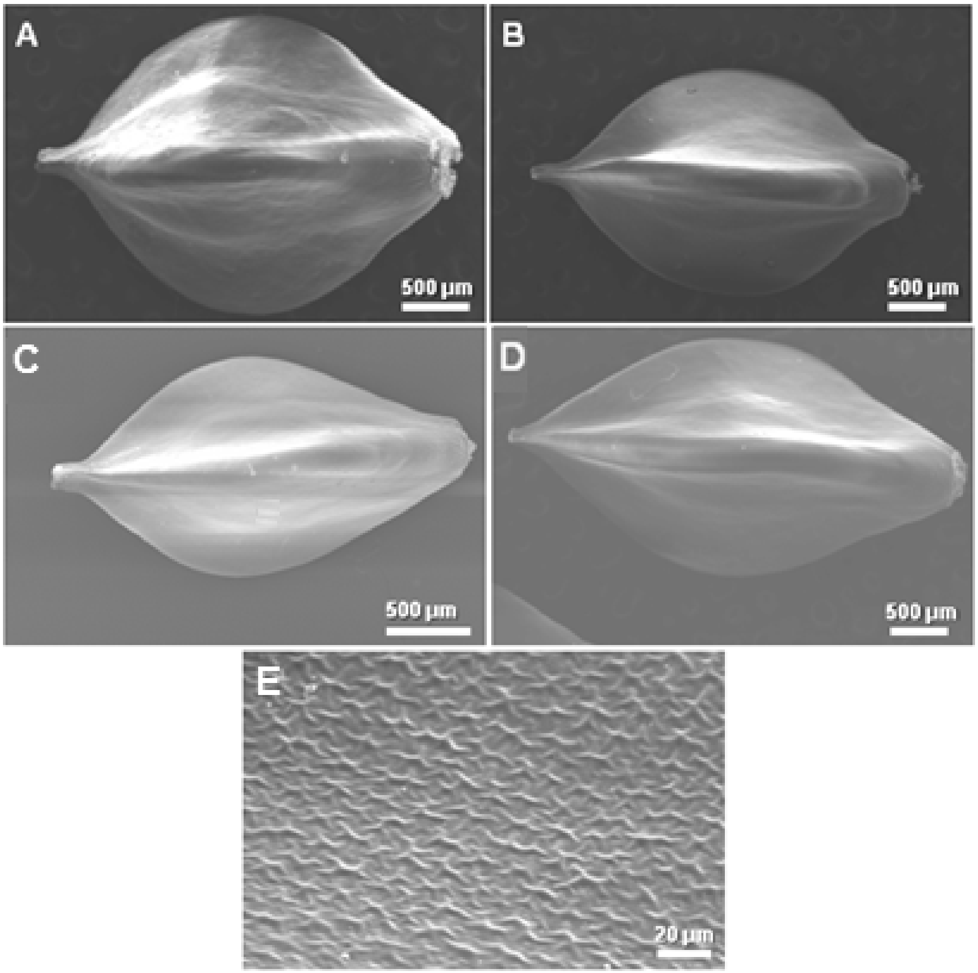

Fig. 7. Achenes and achene surface of the *Bistorta manshuriensis* complex. A. *B. manshuriensis*; B. *B. pacifica*; C., E. *B. alopecuroides*; D. *B. major* var. *ovata*; and E. Achene surface.

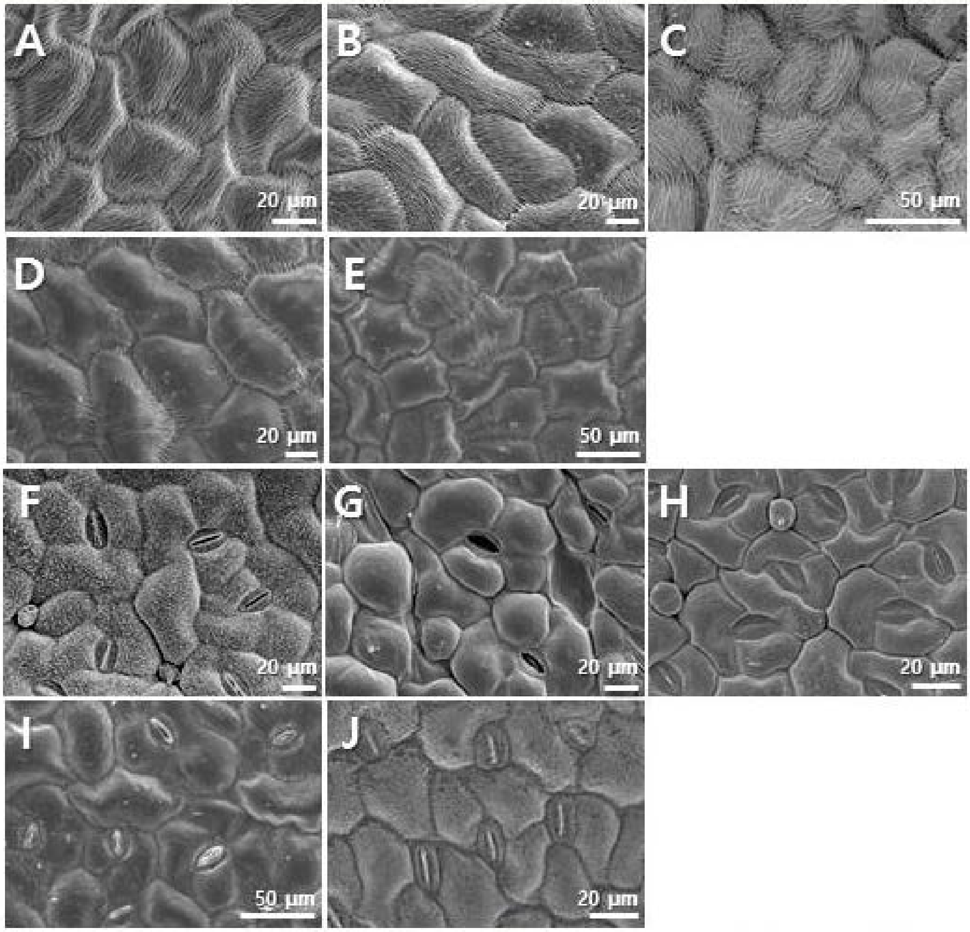

Fig. 8. SEM micrographs of adaxial (A–E) and abaxial (F–J) leaf surfaces of the *B. manshuriensis* complex and closely related taxa. A, F. Korean sample identified as *B. manshuriensis;* B, G. *B. pacifica*; C, H. Korean sample identified as *B. alopecuroides;* D, I. *B. major* var. *ovata;* E, J. *B. major* var. *japonica*.

Table 6. Stomatal characteristics on abaxial leaf surfaces of the *B. manshuriensis* complex and related species.

Taxa and accessions	Stomatal complex		Size of stomata (μm)	
	Type	SP[a]	L: min (mean) max	W: min (mean)max
B. alopecuroides				
kr_gr1	ano, ani	402.1	17.6–(18.3)–20.7	10–(11.2)–13.8
kr_hl16	ano, ani	562.3	15–(18.1)–19.9	6.8–(9.3)–12.1
B. manshuriensis				
kr_ jl3	ano, ani	231.4	18–(21)–23.8	9.3–(12.4)–14.6
kr_hg1	ano, ani	231.4	17.6–(18.5)–22.2	7.4–(11.5)–13.9
rs_kh15	ano, ani	129.8	15.8–(25.2)–29	12.6–(19.3)–16
kr_jm4	ano, ani	99.5	17.2–(19.6)–24.1	9.1–(12.2)–14.9
B. pacifica				
kr_sk1	ano, ani	447.7	15.8–(20.2)–24.8	10.5–(14.6)–2
kr_so7	ano, ani, act	142.7	21.9–(27.5)–29.3	11.27–(14.3)–17.9
rs_nk3	ani, ano	82.2	15.1–(20.6)–27.6	5.6–(10.7)–18.8
B. major* var. *ovata				
O_hk2	ani, ano	199	18–(22.4)–29.2	12.9–(14.6)–18.1
B. major* var. *japonica				
J_hn2	ano, ani, act	233.6	19–(24.4)–29.5	8.6–(12.6)–15.2

List of abbreviations –Type: Act, Actinocytic; Ano, anomocytic; Ani, anisocytic; SP, stomatal presence.

[a]number of stomata per 1 mm^2.

2. Principal components analysis of major morphological characters

The variances accounted for the axes I to III were 39.7, 22.1, and 9.2% respectively. The first two principal axes (I and II) accounted for 61.8% variance. The scatter plot of the specimens on axes I and II are shown in Fig. 9. The samples of *B. manshuriensis* collected from northeast China and some populations of Russian Far East could not be included in the analysis due to the absence of basal leaves in those specimens. The diagram using the first two axes illustrated the taxonomic relationship among the species. Three weakly separated clusters were formed corresponding to *B. pacifica* and *B. major* var. *ovata*, the Korean and Russian samples identified as *B. manshuriensis*, and the Korean samples identified as *B. alopecuroides*. Overlap between the taxa identified as *B. alopecuroides* and *B. manshuriensis*; and between *B. manshuriensis* and *B. pacifica* was evident in the diagram. Almost all of the characters used in this analysis made important contributions to axis 1 (Table 7). Leaf blade width at 1/3, 1/2 and 2/3 point of leaf blade, leaf blade width at the widest point and ratio between width and length of leaf blade were the first five most important characters of this axis (Table 7). The Korean samples identified as *B. alopecuroides* are concentrated on the left side of the diagram where OTUs with smaller and narrower leaves are located. However, the Korean samples identified as *B. alopecuroides* do not form a distinct group as some OTUs are mixed with OTUs of *B. manshuriensis*. Axis II separates *B. manshuriensis* from *B. pacifica*, although some OTUs belonging to one species are still mixed among those of the other. The first five most important characters contributing to axis II were leaf blade length, position of the maximum width in leaf blade, length of the petiole wing, inflorescence length, and ochrea length (Table 7). Due to higher value of PC2, Korean samples identified as *B. manshuriensis* are weakly separated from the cluster of *B. pacifica* and *B. major* var. *ovata*. Compared to *B. pacifica* and *B. major* var. *ovata, B. manshuriensis* has longer basal leaves and tendency of location of maximum leaf width towards the base which results in the predominant distribution of *B. pacifica* on the lower right side of the diagram. These characteristics are shared by four OTUs of *B. major var. ovata* which are thus mixed with the samples of *B. pacifica*. An OTU of *B. pacifica* from Russia was located at extreme right of this cluster. The taxa in the *B. manshuriensis* complex show considerable morphological diversity though the genetic variation was low. The morphological variation of the taxa within the species complex might be a reflection of the microhabitats in which the populations grow (low elevation: seacoast, wetland; high elevation: under the forest in mountain ridges, open area, grassland in mountain peaks). The result of the multivariate analysis supports the transfer of *B. major* var. *ovata* within the *B. pacifica* group.

The taxonomy of the *B. manshuriensis* species complex has been controversial and difficult to assess. The morphological diversity of key diagnostic characters both within a population or taxon and between taxa has led to disagreement among taxonomists about the circumscriptions of species and difficulty in creating usable field keys for the group. In the present study, no cluster was distinct in the PCA plot that corresponded to the currently recognized delimitations of the taxa within the *B. manshuriensis* species complex. It indicated that the diagnostic chacracters based on basal leaves are useful but not adequate to distinguish the three species of the complex, as a sharp separation among was not accomplished in the PCA analysis.

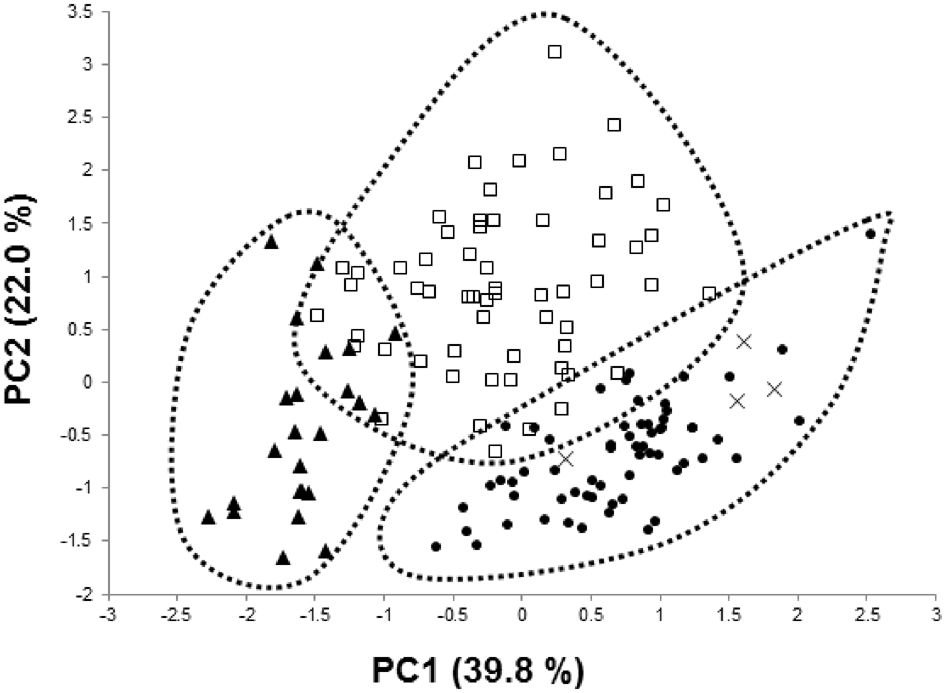

Fig. 9. Ordination of 150 individuals of the *B. manshuriensis* complex and related species along PC1 and PC2 from the principal component analysis using 17 morphological chatacters. Symbols: □ = Korean and Russian samples identified as *B. manshuriensis,* ▲= Korean samples identified as *B. alopecuroides,* ● = *B. pacifica,* ✕ = *B. major* var. *ovata.*

Table 7. Loadings of the first three principal components for 17 morphological characters from the analysis of 150 individuals of the *B. manshuriensis* complex and related taxa. Character numbers correspond to those in Table 1.

Character no.	**PC**		
	1	**2**	**3**
1	0.0543	**0.4749**	0.0539
2	**0.3571**	0.0406	0.0204
3	0.0357	**0.4719**	0.0157
4	0.2359	-0.1992	0.0363
5	0.2890	-0.1763	-0.1466
6	**0.3256**	-0.2026	-0.0508
7	**0.3662**	0.0313	0.0545
8	**0.3652**	0.0079	0.0691
9	**0.3590**	-0.0013	0.0510
10	0.2829	0.1842	-0.1525
11	0.1029	**0.3529**	**0.2157**
12	-0.0374	0.1892	**0.2749**
13	0.2459	-0.1703	-0.2200
14	0.1419	**0.2851**	-0.3974
15	0.2149	-0.0055	**0.3476**
16	0.0397	-0.2214	**0.6668**
17	0.0794	**0.2893**	**0.2088**
Eigenvalue	6.7568	3.74651	1.56239
Cumulative % of eigenvalues	**39.8**	**61.8**	**71.0**

3. Chromosome number

Analysis of mitotic metaphase spreads revealed that the samples of *B. manshuriensis* collected from China and Russia were diploids with 2*n* = 24. The Korean samples identified as *B. manshuriensis* were also diploids. The individuals of *B. pacifica* collected from China, Korea and Russia were tetraploids with 2*n* = 48. In addition, the Korean samples identified as *B. alopecuroides* were also diploids with 2*n* = 24. In contrast, the individuals of *B. alopecuroides* collected from Mongolia were tetraploids with 2*n* = 48. The present study represented the first reported chromosome counts for *B. manshuriensis* and *B. alopecuroides*. The individuals of *B. major* var. *ovata* as well as *B. major* var. *japonica* from Japan were tetraploids with 2*n* = 48 (Fig. 10, Table 8).

Bistorta pacifica was clearly distinguishable from *B. manshuriensis* and the individuals of Jeju island identified as *B. alopecuroides* on the basis of chromosome numbers. Despite extensive sampling, triploids (2*n* = 36) were not found in any of the individuals sampled in this study which suggested that the diploids and tetraploids of the complex are reproductively isolated. Meanwhile, *B. pacifica* and *B. major* var. *ovata* have similar morphology and identical chromosome number which supported the inclusion of the later taxon in *B. pacifica*. The individuals distributed in Mt. Seorak of Korea characterized with narrow leaf blade with subcordate leaf base and undulate leaf margin are closely related to *B. pacifica* on the basis of morphology. However, the plants of Mt. Seorak were cytologically different with diploid (2*n* = 24) chromosome number. Hence, the result indicated that the individuals of Mt. Seorak probably represent a new species.

The previous report of base chromosome number for the genus *Bistorta* is $x = 11$ and 12 (Löve & Löve, 1974; Karlsson, 2000; Freeman & Hinds, 2005). All species assigned to the *B. manshuriensis* complex and included in this study for chromosome counts consistently had the base number $x = 12$. Thus, chromosome base number was stable in the taxa of the *B. manshuriensis* complex, and was also consistent with one of the two base chromosome numbers reported previously for the genus *Bistorta*.

Table 8. Collection data and chromosome numbers for 53 populations of the *B. manshuriensis* complex and closely related taxa examined in this study.

Species	**Locality and voucher**	**Chromosome number (2*n*)**
B. manshuriensis		
	Russia. Primorsky, Khankisky, *Park et al. 59, 83*	24
	Russia. Primorsky, Russia Island, *Park & Choi 54*	24
	China. Jilin, *Park & Choi 27, 7*	24
	China. Heilongjiang, *Park & Choi 74*	24
Korean individuals identified as *B. manshuriensis*		
	Chungbuk, Mt. Seondo, *Bhandari 1052*	24
	Chungnam, Mt. Oseo, *Bhandari 803, 813*	24
	Chungnam, Manripo, *Bhandari 1105*	24
	Chungnam, Guraepo, *Bhandari 16719-6*	24
	Chungnam, Mt. Buchhun, *Bhandari 16711-13*	24
	Gyeongbuk, Mt. Biseul, *Bhandari 1002, 1010*	24
	Gyeongbuk, Gasansanseung, *Won 342, Bhandari 7742*	24
	Jeonnam, Mt. Mudeong, *Bhandari 8055*	24
	Jeonnam, Mt. Byeongfung, *Bhandari 7721, 7731*	24
	Jeonnam, Mt. Duryun, *Bhandari 7030*	24
	Gyeonggi, Mt. Gayeon, *Bhandari 8032*	24
	Gyeonggi, Namhansanseong, *Bhandari 16724-3; -2*	24
	Gyeonggi, Mt. Suwon, *Bhandari 16711*	24

Table 8. (Continued).

Species	**Locality and voucher**	**Chromosome number (2*n*)**
	Gangwon, Mt. Odae, *Bhandari 101, Suh 15628-6*	24
	Gangwon, Mt. Odae, Daegwanryeong, *Suh 1666*	24
	Gangwon, Mt. Odae, Jilmaenuf, *Bhandari*, *Suh01*	24
	Gangwon, Mt. Daerung, *Bhandari* 52	24
	Gyeongnam, Mt. Jagul, *Bhandari 7752*	24
	Gyeongnam, Mt. Bulmo, *Won 579*	24
	Gyeongnam, Mt. Jongnam, *Bhandari 635, 636*	24
B. pacifica		
	Russia. Primorsky, Shkotovsky, *Park et al. 13*	48
	Russia. Primorsky, Ussurisk, *Park & Choi 107, 108*	48
	China. Jilin, *Choi 003; Park & Choi 53*	48
	Korea. Chungbuk, Mt. Sobaek, *Bhandari 4*	48
	Korea. Chungbuk, Mt. Minjuji, *Bhandari 1515*	48
	Korea. Gangwon, Mt. Taebaek, *Bhandari 702*	48
	Korea. Gangwon, Mt. Gyebang, *Bhandari 12724-9*	48
	Korea. Gangwon, Mt. Gariwang, *Bhandari 153*	48
	Korea. Gangwon, Mt. Dae-am, *Suh et al. 823-6, 823-14, 1584-5*	48
	Korea. Gangwon, Mt. Hambaek, *Bhandari 7082*	48
	Korea. Gangwon, Geumdaebong, *Bhandari 7092*	48

Table 8. (Continued).

Species	**Locality and voucher**	**Chromosome number (2*n*)**
	Korea. Gangwon, Mt. Hambaek, Manhangje, *Suh 1575-7, Bhandari 16630-34*	48
	Korea. Mt. Cheongok, *Bhandari 16630-1*	48
	Korea. Gangwon, Mt. Seorak, *Bhandari621-1, 2007-5*	24
	Korea. Jeonbuk, Mt. Jiri, *Bhandari 502, 517, 518*	48
	Korea. Gyeonggi, Mt. Hwaak, *Bhandari 202, 208*	48
B. alopecuroides		
	Mongolia. *Park & Kim B9*	48
Korean individuals identified as *B. alopecuroides*		
	Gyeongnam, Mt. Gara, *Won 608*	24
	Jeju, Mt. Halla, *Won & Bhandari 313*, *Kim 14904-5*	24
	Jeju, Mt. Halla, Witseoreum, *Kim 14904-2*	24
B. major var. *ovata*		
	Japan. Hokkaido, Mt. Obira, *Kim 32*	48
B. major var. *japonica*		
	Japan. Honshu, Nikko, *Park et al. 198*	48

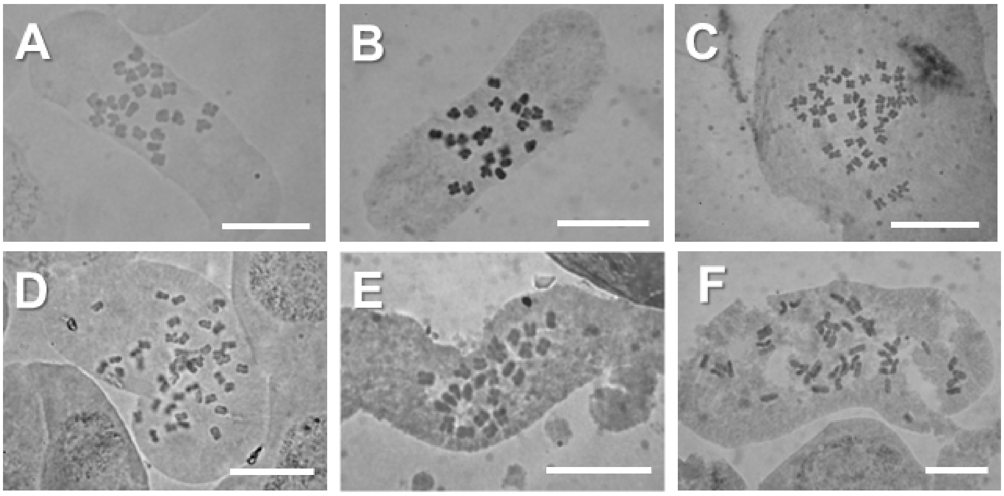

Fig. 10. Somatic chromosomes of the *B. manshuriensis* complex and closely related taxa. A. *B. manshuriensis* (2*n* = 24; *Park & Choi 27*); B. Korean sample identified as *B. manshuriensis* (2*n* = 24; *Bhandari 635*); C. *B. pacifica* (2*n* = 48; *Bhandari 4*); D. *B. major* var. *ovata* (2*n* = 48; *Kim 32*); E. Korean sample identified as *B. alopecuroides* (2*n* = 24; *Won & Bhandari 313*); F. *B. alopecuroides* (2*n* = 48; *Park & Kim 9*); See Table 8 for voucher information. Scale bars = 10 µm.

4. DNA sequencing

(1) Nuclear DNA

The sequence characteristics of ITS region are presented in Table 9. Total alignment of ITS1-5.8S-ITS2 was 593 bp in length. The length of ITS1, 5.8S rDNA and ITS2 was 196–197 bp, 164 bp and 232 bp respectively in all ingroup accessions. The GC content varied from 62.4–62.7% in ITS1 and 68.8–70.1% in ITS2. The percentage of GC content in the taxa of the complex was similar to that of other species of Polygonaceae (Yoo, 2000; Wan et al., 2014). The ITS sequence data revealed the presence of 28 ribotypes in the complex based on 23 variable sites. The distribution pattern of ribotypes in the populations of the *B. manshuriensis* complex and related taxa is presented in Table 11. Nine ribotypes (R1, R2, R4, R5, R7, R9, R10, R13 and R21) were shared by two or more taxa of the complex. Ribotype R1 was geographically widespread, and was distributed in nearly all individuals of all taxa of the complex. *Bistorta manshuriensis* and *B. pacifica* contained seven and 15 ribotypes respectively. Five ribotypes (R1, R2, R4, R5 and R7) were shared by *B. pacifica*, Korean populations identified as *B. manshuriensis*, and Korean populations identified as *B. alopecuroides*. *Bistorta pacifica* and *B. major* var. *ovata* shared five ribotypes in total. Twelve ribotypes were population-specific. In Korea, populations identified as *B. manshuriensis* and *B. alopecuroides* possessed seven and eight ribotypes in total respectively. Meanwhile, three populations identified as *B. manshuriensis* in Khanka region of Russia harbored five ribotypes. One to four ribotypes were found in each of the 39 individuals sampled in nine populations of *B. manshuriensis* from Russia and China. Two to four ribotypes were found in 12 individuals sampled from 10 populations in Korea identified as *B. manshuriensis*. Similarly, in *B. pacifica*, 19 accessions sampled from 16 populations were polymorphic. Two to six ribotypes were found in six individuals sampled from three Korean populations identified as *B. alopecuroides*. All Korean individuals of the *B. manshuriensis* complex as well as *B. major* var. *japonica*, *B. major* var. *ovata* and *B. alopecuroides* sampled in this study were polymorphic. Thus, ribotype polymorphism was prevalent in all taxa of the *B. manshuriensis* complex. In addition, the ribotypes of some individuals resolved in different clades, which suggested occurrence of gene flow among the taxa and populations of the complex.

The NJ tree inferred from 28 ribotypes is shown in Fig. 11. The tree resolved the *B. manshuriensis* complex as highly supported monophyletic group (PP = 1). The tree was largely unresolved and the individuals of the taxa were grouped in four major clades. However, the individuals of *B. manshuriensis*, *B. pacifica*, *B. alopecuroides* and *B. major* var. *ovata* did not form monophyletic groups.

(2) Chloroplast DNA

Initially, analysis of chloroplast DNA included six coding and non-coding regions: two protein coding genes (*matK* and *ndhF*), two introns (*trnK* and *rpl16*) and two intergenic spacers (*psbA-trnH* and *rbcL-accD*). The sequence characteristics of the examined cpDNA regions are presented in Table 12. A 30 bp inversion (hair-pin structure) was inferred in *psbA-trnH* IGS in two Russian populations of *B. manshuriensis* and three Korean populations identified as

Table 9. Sequence characteristics of nuclear rDNA ITS regions of the *B. manshuriensis* complex and closely related taxa.

	rDNA ITS			
	ITS 1	**5.8S**	**ITS 2**	Total
Amplified length (bp)				
Ingroup	196–197	164	232	592–593
Outgroup	196	164	230	590
Aligned length (bp)	197	164	232	593
Number of indels	1	0	2	3
Number of variable characters (outgroup excluded)	20 (11)	1 (1)	26 (11)	47 (23)
Number of parsimony informative characters (outgroup excluded)	14 (6)	1 (1)	16 (8)	31 (15)
G+C content (%)	62.4–62.7	55.5–56.1	68.8–70.1	62.9–63.6

Table 10. A summary of variable sites for ITS in the individuals of the *B. manshuriensis* complexdetected through direct sequencing and cloning.

Ribo-type	Variable nucleotide sites																					
	029	049	055	063	064	075	144	156	177	186	192	210	328	383	393	457	492	499	506	525	542	544
R1	C	C	G	C	G	G	C	A	G	C	-	G	C	C	T	C	A	T	T	C	C	A
R2	C	C	G	T	G	G	C	A	G	C	-	G	C	T	T	C	A	T	T	C	C	A
R3	C	C	G	T	G	G	C	A	G	C	-	G	C	T	T	T	A	T	T	C	C	A
R4	C	C	G	C	G	G	C	A	G	C	-	G	C	T	T	C	A	T	T	C	C	A
R5	C	C	G	T	G	G	C	A	G	C	-	G	C	C	T	C	A	T	T	C	C	A
R6	C	C	G	C	G	G	C	G	G	C	-	G	C	C	T	C	A	T	T	C	C	A
R7	C	C	G	C	G	G	C	A	G	C	-	G	C	C	A	C	A	T	T	C	C	A
R8	C	C	G	C	G	G	C	A	G	C	-	G	A	T	T	C	A	T	T	C	C	A
R9	C	C	G	C	G	G	C	A	G	C	-	G	C	C	T	C	A	T	T	T	C	A
R10	C	C	G	T	G	G	C	A	G	C	C	G	C	C	T	C	A	T	T	T	C	A
R11	C	C	G	T	G	G	C	A	G	C	-	G	C	C	T	C	A	T	G	C	C	A
R12	C	C	G	C	G	G	C	A	G	C	-	G	C	C	T	C	A	T	G	C	C	A
R13	C	C	G	C	G	G	C	A	G	C	-	G	C	C	T	C	A	T	G	C	C	A
R14	T	C	G	C	G	G	C	A	G	C	-	G	C	C	T	C	A	T	G	C	C	A
R15	C	C	G	A	G	G	C	A	G	C	-	G	C	C	T	C	A	T	T	C	C	A
R16	C	C	G	C	G	G	C	A	A	C	-	G	C	C	T	C	A	A	T	C	C	A
R17	C	C	G	T	G	G	C	A	G	C	-	G	C	C	T	C	G	T	T	C	C	A
R18	C	C	C	C	G	G	C	A	G	C	-	G	C	C	T	C	A	T	T	C	C	A
R19	C	C	G	C	G	G	G	A	G	C	-	G	C	C	T	C	A	T	T	C	C	A
R20	C	C	G	C	G	G	C	A	G	C	-	G	C	C	T	C	G	T	T	C	C	A
R21	C	C	G	C	A	G	T	A	G	C	-	G	C	C	A	C	A	T	T	C	C	A
R22	C	C	G	C	G	G	C	A	G	C	-	G	C	C	T	C	A	T	T	C	A	A
R23	C	C	G	C	A	G	C	A	G	C	-	G	C	C	T	C	A	T	T	C	C	A
R24	C	C	G	C	G	G	C	A	G	T	-	G	C	C	T	C	A	T	T	C	C	A
R25	C	C	G	C	G	G	C	A	G	C	-	A	C	C	T	C	A	T	T	C	C	A
R26	C	C	G	C	G	A	C	A	G	C	-	G	C	C	T	C	A	T	T	C	C	A
R27	C	T	G	C	G	G	C	A	G	C	-	G	C	C	T	C	A	T	T	C	C	A
R28	C	C	G	C	G	G	C	A	G	C	-	G	C	C	T	C	A	T	T	C	C	G

Table 11. Ribotype distribution in the populations of the *B. manshuriensis* complex and related taxa. Population code correspond to the codes in Table 2.

Population	Taxon/Accessions	Ribotypes																											
		01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
	B. manshuriensis																												
M1, 2	rs_kb1, rs_kh1, 2	●																											
M2	rs_kh3	●						●		●																●			
M3	rs_kh4, 9–11, 12–19, 22–24, 27, 29, 30	●																											
M3	rs_kh31	●								●																●			
M3	rs_kh8, 20, 25, 28	●						●																					
M4	rs_kh32	●																										●	
M5	rs_ot1	●																											
M6	rs_is2	●																											●
M8	cn_hj4	●																									●		
M8, 11, 12	cn_hj2, cn_ul1, cn_sb1	●																											
	Korean individuals identified as *B. manshuriensis*																												
M14	kr_jm1		●		●																								
M18	kr_hg1	●			●																								
M20	kr_nh1	●	●		●	●																							
M21	kr_gu1	●			●			●														●							
M22, 25	kr_mp1, kr_os1	●						●																					
M28	kr_bs1	●			●	●																							
M30, 32	kr_bu1, kr_mt1	●				●																							

Table 11. (Continued).

Population	Taxon/Accessions	Ribotypes																											
		01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
M33	kr_md2	●																							●				
M34	kr_dn2	●				●																							
M35	kr_sm2	●				●		●																					
	B. pacifica																												
P1	rs_ms1	●				●							●																
P1	rs_ms3	●	●								●	●	●	●															
P2	rs_nk1, 2	●																											
P4	rs_pr3	●																	●										
P5	rs_rc1	●			●					●							●			●									
P6	rs_rc7	●																											
P7	rs_us2	●				●						●		●		●													
P10	cn_jl1	●								●																			
P11	cn_jl3	●	●																										
P12	cn_sn2	●	●							●								●											
P13	cn_mc1	●				●															●								
P13	cn_mc2	●	●		●																●								
P14, 15	kr_hw1, kr_dm1	●	●	●																									
P16	kr_sk2		●	●			●																						
P16	kr_sk5		●	●																									
P17	kr_sh1	●	●		●	●	●		●																				
P19	kr_gw1	●	●	●	●																								
P19	kr_gw2	●	●	●																									
P20	kr_ck2	●	●	●	●	●																							
P21	kr_hc1	●	●		●	●		●																					

Table 11. (Continued).

Population	Taxon/Accessions	Ribotypes																											
		01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
P24	kr_mh1	●	●			●		●																					
P25	kr_tb1	●	●	●																									
P28	kr_il1	●	●		●	●	●																						
P29, 30	kr_mj1, kr_dk1	●	●		●	●																							
P31	kr_jr1	●	●		●																								
	B. major var. *ovata*																												
O1	jp_rb1	●				●					●	●			●														
O2	jp_hk2	●										●		●	●														
	B. alopecuroides																												
A7, 8	mn1, mn2	●												●															
	Korean individuals identified as *B. alopecuroides*																												
A1	kr_gr1	●																					●						
A2	kr_hl3	●				●																							
A2	kr_hl4	●						●																					
A5	kr_hl10	●	●		●	●																●		●					
A5	kr_hl11, 13	●						●																					

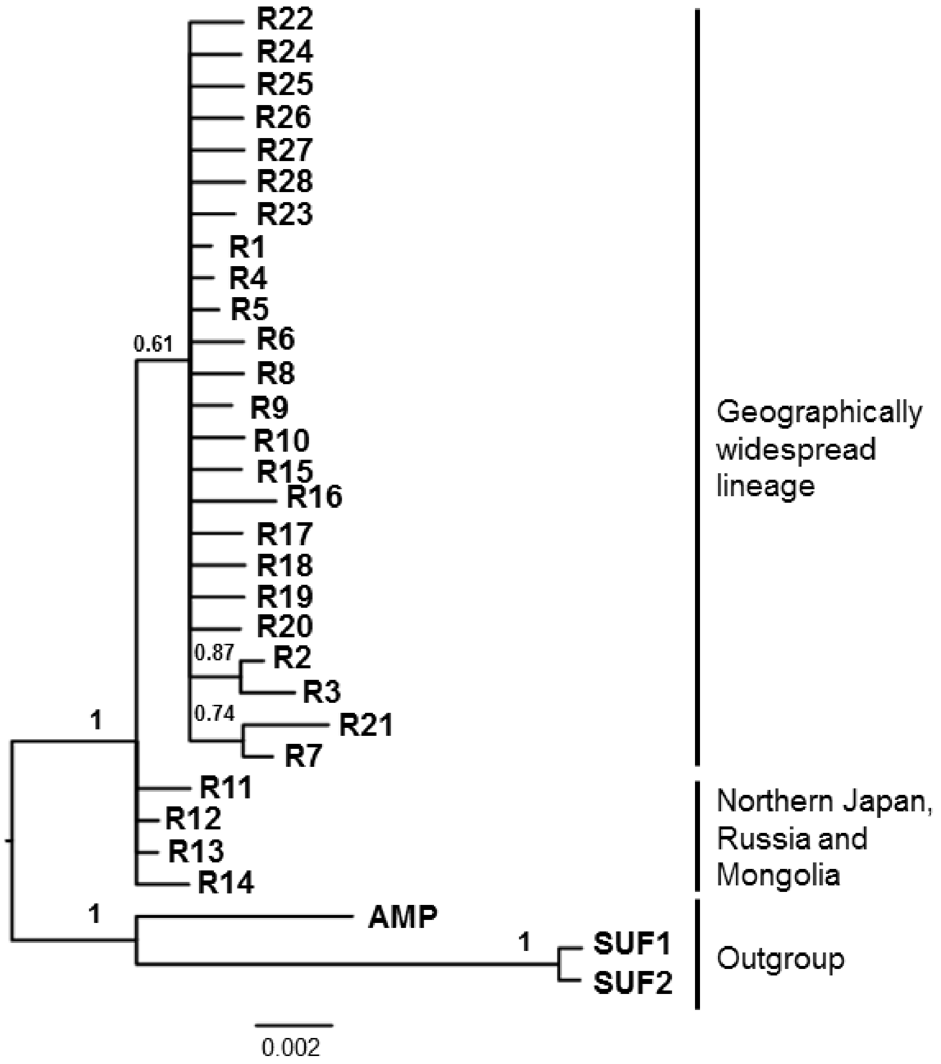

Fig. 11. The Neighbor-Joining tree showing phylogenetic relationship of ITS ribotypes. Names at the tips of branches indicate the ribotypes and outgroup taxa. Numbers above branches indicate posterior probabilities.

B. alopecuroides (Fig. 12). Mapping inverted and non-inverted sequence variants on *psbA-trnH* tree showed that the inversion probably occurred independently several times. Thus, the *B. manshuriensis* complex provided additional example of homoplasious nature of small inversions in non-coding chloroplast DNA (Whitlock et al. 2010). The combined cpDNA data set included 5785 base positions. The *rbcL-accD* IGS sequences contained the lowest percent (1.1%) and the *psb*A-*trn*H IGS sequences contained the highest percent (6.2%) of parsimony informative characters when outgroup taxa were excluded. The pairwise sequence divergences between ingroup taxa calculated using uncorrected P-distance method ranged from 0 to 0.004%. The number of variable sites in ingroup taxa was 109 (1.2%), including 70 parsimony informative characters. Preliminary analyses based on different combinations of the six cpDNA regions indicated that the IGS regions (*psbA-trnH* and *rbcL-accD*) and *rpl16* intron were not useful in resolving relationship and were prone to homoplasy due to higher rate of sequence evolution (as shown by large number of indels in alignment). Hence, these three regions were excluded from further analyses. Because there is no recombination within the cpDNA molecule, the three cpDNA regions were combined. The aligned data matrix for the combined analysis of cpDNA (*trnK* + *matK* + *ndhF*) consisted of 3803 bp for outgroup and ingroup accessions. No insertions and deletions were found in ingroup alignment except a single 1-bp indel in *trnK* region (Tabel 13).

(3) Distribution of cpDNA haplotypes

Based on the analysis of sixty six nucleotide substitutions and one 1-bp indel in the combined sequence alignment of three cpDNA regions, 43 haplotypes

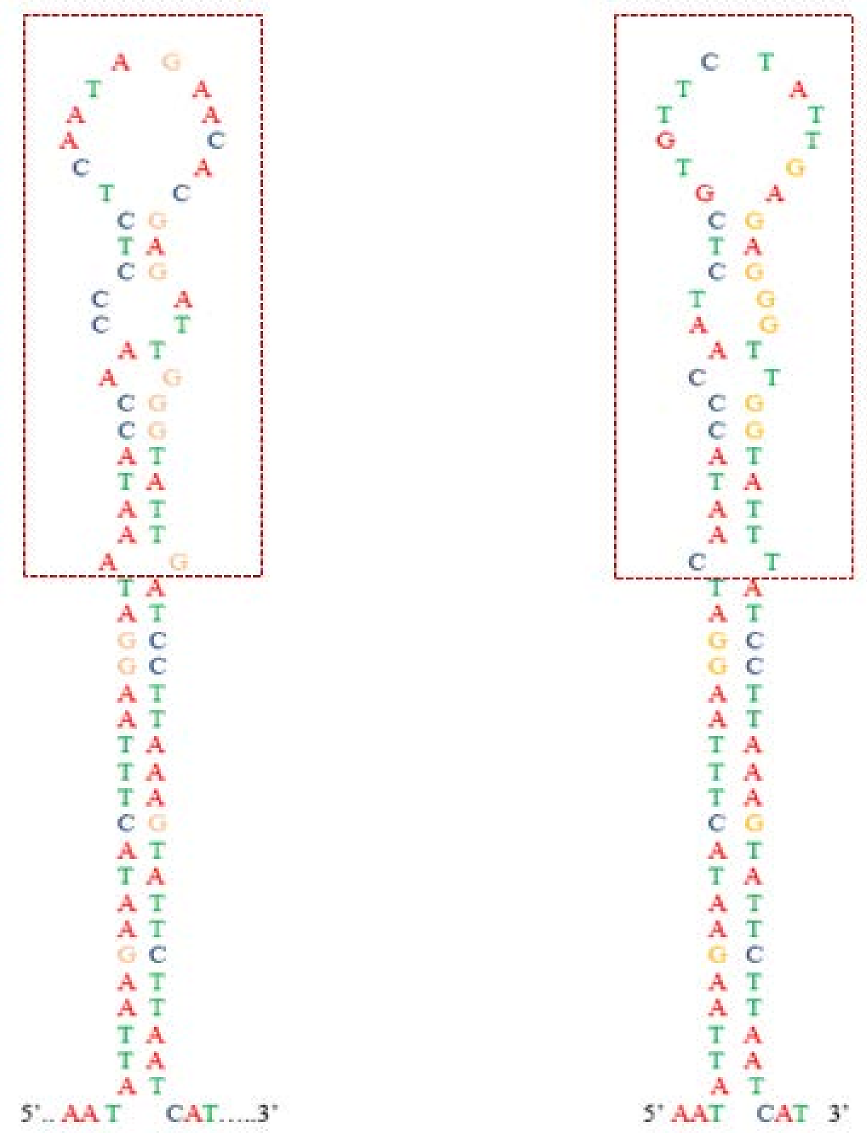

Fig. 12. Predicted secondary structures of the *psbA*-*trnH* IGS region of the *B. manshuriensis* complex and related taxa. Boxes with broken line indicate the inverted region. Inversion begins from base number 98 to 178 in the aligned sequence data of *psbA*-*trnH* IGS.

Table 12. Sequence characteristics of *trnK* intron, *matK* gene, *psbA-trnH* IGS, *rpl16* intron *ndhF* gene and *rbcL-accD* IGS regions and combined dataset in the *B. manshuriensis* complex and related taxa.

		cpDNA regions						
		trnK	***matK***	***psbA-trnH***	***rpl16***	***ndhF***	***rbcL-accD***	**Combined**
Amplified length (bp)	**ingroup**	675–676	1133	319–425	868–915	1993	493–531	5482–5594
	outgroup	667–676	1133	294	877–889	1993	501–502	5475–5477
Aligned length (bp)		677	1133	486	952	1993	544	5785
No. of characters excluded		0	0	153	0	0	0	153
No. of variable characters (outgroup excluded)		22 (11)	40 (19)	26 (15)	26 (17)	73 (37)	17 (10)	204 (109)
No. of parsimony informative characters (outgroup excluded)		12 (5)	26 (13)	20 (11)	19 (11)	53 (24)	12 (6)	142 (70)
% informative characters (outgroup excluded)		1.8 (0.7)	6.2 (1.1)	4.1 (3.4)	2 (1.2)	2.7 (1.2)	2.2 (1.1)	2.5 (1.2)
Pairwise sequence divergence between all haplotypes of ingroup (%)		0–0.007	0–0.005	0–0.02	0–0.011	0–0.005	0–0.006	0–0.004
GC content (%) (ingroup only)		33.3–33.8	32.3–32.6	20.1–26.1	31.8–32.9	33.7–33.9	34.1–35.1	32.3–33

Table 13. Variable nucleotide sites in *trnK*, *matK* and *ndhF regions*.

Haplotype	*trnK*											*matK*																			
	0129	0130	0150	0257	0259	0282	0326	0365	0422	0574	0616	0814	0820	0828	0838	0951	0986	1018	1048	1049	1118	1133	1217	1222	1290	1334	1371	1423	1555	1601	1629
1	C	A	T	A	G	A	T	G	C	T	-	C	C	A	A	C	T	G	T	A	A	T	A	G	C	T	A	T	T	T	A
2	C	A	T	A	G	A	T	G	C	T	-	C	C	A	A	C	T	G	T	A	A	T	C	G	C	T	A	T	T	T	C
3	C	A	T	A	G	A	T	G	C	T	-	C	C	A	A	C	T	G	T	A	A	T	A	G	C	T	A	T	T	T	A
4	C	A	T	A	G	A	T	G	C	T	-	C	C	A	A	C	T	G	T	A	A	T	A	G	C	T	A	T	T	T	A
5	C	A	T	A	G	A	T	G	C	T	-	C	C	A	A	C	T	G	T	A	A	T	A	G	C	T	A	T	C	T	A
6	C	A	T	A	G	A	T	G	C	T	-	C	C	A	A	C	T	G	T	A	A	T	C	G	C	T	A	T	T	T	A
7	C	A	T	A	G	A	T	G	C	T	-	C	C	A	A	C	T	G	T	A	A	T	A	G	C	T	A	T	T	T	A
8	C	A	T	A	G	A	T	G	C	T	-	C	C	A	A	C	T	G	T	A	A	T	A	G	C	T	A	T	T	T	A
9	A	A	T	A	T	A	G	G	C	T	-	C	C	A	A	C	T	G	G	A	A	T	A	G	C	T	A	T	T	T	A
10	C	A	C	A	G	A	T	G	C	T	-	C	C	A	A	C	T	G	T	A	A	T	A	G	C	T	A	T	T	T	A
11	C	A	T	A	G	A	T	G	C	T	-	C	C	A	A	C	T	G	T	A	A	T	A	G	C	T	A	T	T	T	A
12	C	A	T	A	G	A	T	G	C	C	-	C	C	A	A	C	T	G	T	A	A	T	A	G	C	T	A	T	T	T	A
13	C	A	T	A	G	A	T	T	C	T	-	C	C	A	A	C	T	G	T	A	A	T	A	G	C	T	A	T	T	T	A
14	C	A	T	A	G	A	T	G	C	T	-	C	C	A	A	C	T	G	T	A	A	T	C	G	C	T	A	T	T	T	A
15	C	A	T	A	G	A	T	G	C	T	-	C	C	A	A	C	T	G	T	A	A	T	C	G	C	T	A	T	T	T	A
16	C	A	T	A	G	A	T	G	C	T	-	C	C	A	G	C	T	G	T	A	A	T	A	G	C	T	A	T	T	T	A
17	C	A	T	A	G	A	T	G	C	T	A	C	C	A	A	C	T	G	T	A	A	T	A	G	C	T	A	T	T	T	A
18	C	A	T	A	G	A	T	G	C	T	-	C	C	A	A	C	T	A	T	A	A	T	A	G	C	T	A	T	T	A	A
19	C	A	T	A	G	A	T	G	C	T	-	C	C	A	A	C	T	G	T	A	A	T	A	G	C	T	A	T	T	T	A
20	C	A	T	A	G	A	T	G	C	T	-	C	C	A	A	C	T	G	T	A	A	T	A	G	C	T	A	T	T	T	A
21	C	A	T	A	G	A	T	G	C	T	-	C	C	A	A	C	T	G	T	A	A	T	A	G	C	T	A	T	T	T	A
22	C	A	T	A	G	A	T	G	C	T	-	C	C	A	A	C	T	G	T	A	A	T	A	G	C	T	A	T	T	T	A
23	C	A	T	A	G	A	T	G	C	T	-	C	C	A	G	C	T	G	T	A	A	T	A	G	C	T	A	T	T	T	A
24	A	A	T	A	T	A	G	G	C	T	-	C	C	A	G	C	T	G	T	A	A	T	A	G	C	T	A	T	T	T	A
25	A	A	T	A	T	A	G	G	C	T	-	C	C	A	G	C	T	G	T	A	A	T	A	G	C	T	A	T	T	T	A
26	A	A	T	A	T	A	G	G	C	T	-	C	C	A	A	C	T	G	T	A	A	T	A	G	C	T	A	T	T	T	A
27	A	A	T	A	T	A	G	G	C	T	-	C	C	A	A	C	T	G	T	A	A	T	A	G	C	T	A	T	T	T	A
28	A	A	T	A	T	A	G	G	C	T	-	C	C	A	A	C	T	G	T	A	A	T	A	A	C	T	A	T	T	T	A
29	A	A	T	A	T	A	G	G	C	T	-	C	C	A	A	C	T	G	T	A	A	T	A	G	C	T	A	T	T	T	A
30	A	A	T	A	T	A	G	G	C	T	-	C	C	A	A	C	T	G	T	A	A	T	A	G	C	G	A	T	T	T	A
31	A	A	T	A	T	A	G	G	C	T	-	C	C	A	A	C	T	G	T	A	A	T	A	G	C	G	A	T	T	T	A
32	A	C	T	A	T	A	T	G	C	T	-	C	C	A	A	C	T	G	T	C	A	T	A	G	C	T	A	G	T	T	A
33	A	C	T	A	T	A	T	G	C	T	-	C	C	A	A	C	T	G	T	C	A	T	A	G	C	T	A	G	T	T	A
34	C	C	T	A	T	A	T	G	C	T	-	C	C	A	A	C	T	G	T	C	A	T	A	G	C	T	A	T	T	T	A
35	C	C	T	A	T	A	T	G	C	T	-	C	C	A	A	C	T	G	T	C	A	T	A	G	A	T	A	T	T	T	A
36	A	C	T	A	T	A	T	G	C	T	-	C	C	A	A	C	T	G	T	C	C	T	A	G	C	T	A	T	T	T	A
37	A	C	T	A	T	A	T	G	C	T	-	C	C	A	A	C	T	G	T	C	A	T	A	G	C	T	A	T	T	T	A
38	A	C	T	C	T	A	T	G	C	T	-	C	C	A	A	C	T	G	T	C	A	T	A	G	C	T	A	T	T	T	A
39	A	C	T	A	T	A	T	G	C	T	-	C	C	A	A	C	T	G	T	C	A	T	A	G	C	T	C	T	T	T	A
40	A	C	T	A	T	A	T	G	A	T	-	C	C	A	A	A	T	G	T	C	A	T	A	G	C	T	A	T	T	T	A
41	A	C	T	A	T	A	T	G	C	T	-	C	A	G	A	C	T	G	T	C	A	T	A	G	C	T	A	T	T	T	A
42	A	C	T	A	T	C	T	G	C	T	-	C	C	A	A	C	T	G	T	C	A	G	A	G	C	T	A	T	T	T	A
43	A	C	T	A	T	C	T	G	C	T	-	T	C	A	A	C	C	G	T	C	A	G	A	G	C	T	A	T	T	T	A

Table 13. (Continued).

Haplotype	*ndhF*																																		
	1964	2017	2037	2363	2383	2386	2398	2410	2435	2443	2491	2599	2633	2653	2844	3063	3106	3216	3250	3253	3285	3318	3352	3371	3389	3492	3510	3553	3598	3607	3664	3672	3698	3728	3759	3784
1	T	T	T	C	C	T	G	C	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	G	T	G	A	A	C	A	C	A	G
2	T	T	T	C	C	T	G	C	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	G	T	G	A	A	C	A	C	A	G
3	T	T	T	C	C	T	G	C	G	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	G	T	G	A	A	C	A	C	A	G
4	T	T	T	C	C	T	G	C	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	G	T	G	A	A	C	C	C	A	G
5	T	T	T	C	C	T	G	C	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	G	T	G	A	A	C	A	C	A	G
6	T	T	T	C	C	T	G	C	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	G	T	G	A	A	C	A	C	A	G
7	T	T	T	C	C	T	G	C	A	A	A	G	T	A	T	C	G	A	T	C	T	A	T	A	G	A	G	T	G	A	A	C	A	C	A	G
8	T	T	T	C	C	T	G	C	A	A	A	G	T	A	T	C	G	A	T	C	T	A	T	A	G	A	G	T	A	A	A	C	A	C	A	G
9	T	T	C	C	C	T	G	A	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	G	T	G	T	A	C	A	C	A	G
10	T	T	T	C	C	T	G	C	A	A	A	G	T	C	T	C	G	A	T	C	T	A	T	A	G	A	G	T	G	A	A	C	A	C	A	G
11	T	T	T	C	C	T	T	C	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	G	T	G	A	A	C	A	C	A	G
12	T	T	T	C	C	T	T	C	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	G	T	G	A	A	C	A	C	A	G
13	T	T	T	C	C	T	T	C	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	G	T	G	A	A	C	A	C	A	G
14	T	T	T	C	C	T	G	C	A	T	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	G	T	G	A	A	C	A	C	A	G
15	T	T	T	C	C	T	G	C	A	A	A	G	T	A	C	C	A	A	T	C	T	A	T	A	G	A	G	T	G	A	A	C	A	C	A	G
16	T	T	T	C	C	T	G	C	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	G	G	A	G	T	G	A	A	C	A	C	A	G
17	T	T	T	C	C	T	G	C	A	A	A	G	T	A	C	C	G	A	T	C	A	A	T	A	G	A	G	T	G	A	A	C	A	C	A	G
18	T	T	T	C	A	T	G	C	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	G	T	G	A	A	C	A	C	A	G
19	T	T	T	C	C	T	G	C	A	A	A	G	T	A	C	C	G	A	T	G	T	A	T	A	G	A	G	T	G	A	A	C	A	C	A	G
20	G	T	T	A	C	T	G	C	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	G	T	G	A	A	C	A	C	A	G
21	T	T	T	C	C	T	G	C	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	G	C	G	A	A	C	A	C	A	G
22	T	T	T	C	C	T	G	C	A	A	A	G	T	A	C	C	G	A	T	C	T	T	T	A	G	A	G	C	G	A	A	C	A	C	A	G
23	T	T	T	C	C	T	G	C	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	G	T	G	A	A	C	A	C	A	A
24	T	T	T	C	C	T	G	C	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	G	T	G	A	A	C	A	C	A	A
25	T	T	T	C	C	T	G	C	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	G	T	G	A	A	C	A	C	A	G
26	T	T	C	C	C	T	G	A	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	G	T	G	A	A	C	A	C	A	G
27	T	C	C	C	C	T	G	A	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	G	T	G	A	A	C	A	C	A	G
28	T	T	C	C	C	T	G	A	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	G	T	G	A	A	C	A	A	A	G
29	T	T	C	C	C	T	G	A	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	G	T	G	A	A	C	A	A	A	G
30	T	T	C	C	C	T	G	A	A	A	A	T	T	A	C	C	G	A	T	C	T	A	T	A	G	A	G	T	G	A	A	C	A	A	G	G
31	T	T	C	C	C	T	G	A	A	A	A	T	T	A	C	C	G	T	T	C	T	A	T	A	G	A	G	T	G	A	A	C	A	C	G	G
32	T	T	C	C	C	T	G	A	A	A	C	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	G	T	G	A	A	C	A	C	A	G
33	T	T	C	C	C	T	G	A	A	A	C	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	T	T	G	A	A	C	A	C	A	G
34	T	T	C	C	C	T	G	A	A	A	C	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	T	T	G	A	A	C	A	C	A	G
35	T	T	C	C	C	C	G	A	A	A	C	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	T	T	G	A	A	C	A	C	A	G
36	T	T	C	C	C	T	G	A	A	A	A	G	T	A	C	C	G	A	A	C	T	A	T	A	G	A	T	T	G	A	A	C	A	C	A	G
37	T	T	C	C	C	T	G	A	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	T	T	G	A	A	C	A	C	A	G
38	T	T	C	C	C	T	G	A	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	T	T	G	A	C	C	A	C	A	G
39	T	T	C	C	C	T	G	A	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	A	T	T	G	C	C	C	A	C	A	G
40	T	T	C	C	C	T	G	A	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	A	A	T	T	G	A	A	C	A	C	A	G
41	T	T	C	C	C	T	G	A	A	A	A	G	T	A	C	C	G	A	T	C	T	A	T	A	G	C	T	T	G	A	A	C	A	C	A	G
42	T	T	C	C	C	T	G	A	A	A	A	G	A	A	C	T	G	A	T	C	T	A	G	A	G	A	T	T	G	A	A	A	A	C	A	G
43	T	T	C	C	C	T	G	A	A	A	A	G	A	A	C	T	G	A	T	C	T	A	G	A	G	A	T	T	G	A	A	A	A	C	A	G

were identified from 182 accessions of ingroup taxa. The geographical distribution of all forty three cpDNA haplotypes is shown in Fig. 13. The distribution pattern of these haplotypes in the populations and taxa of the *B. manshuriensis* complex is given in Table 14. In *B. manshuriensis* sampled from northeast China and Russian Far East, 12 different haplotypes were detected in 47 individuals. Forteen haplotypes were detected in 38 Korean individuals identified as *B. manshuriensis*. Similarly, thirteen haplotypes were detected in 69 individuals of *B. pacifica*. In addition, nine different haplotypes were found in 16 individuals of Mt. Halla identified as *B. alopecuroides*. Three haplotypes were distributed in three individuals of *B. major* var. *japonica* and two haplotypes were found in five individuals of *B. major* var. *ovata*. Among forty three haplotypes, eight haplotypes (H1, H6, H7, H11, H14, H34, H41, and H43) were shared by two or more taxa of the complex (Table 14). Among the shared haplotypes, five (H1, H6, H7, H41, and H43) were shared by diploid and tetraploid individuals. Among forty three cpDNA haplotypes, 27 were population-specific. Forty one populations were represented by two or more individuals, and among them, eighteen populations (43.9%) contained multiple haplotypes. Thus, the number of polymorphic populations was substantial in the complex. Meanwhile, Mt. Halla of Jeju Island possessed significantly high number of haplotypes with nine haplotypes distributed over five adjacent populations identified as *B. alopecuroides*. Some populations harbored surprisingly high level of cpDNA haplotypes. For example, a total of three haplotypes were detected in four individuals sampled from a population in Mt. Oseo of Korea. H1 was the most common haplotype occurring in 34 populations (41.5% of the total). Among thirty four populations which harbored haplotype H1, thirty one were distributed in Korea only (Fig. 13). The remaining three populations with haplotype H1 were located in Russian Far East. Haplotype H1 was distributed in 15 populations of *B. pacifica*, and 17 populations from Korea identified as *B. manshuriensis* as well as two populations from Korea identified as *B. alopecuroides*. Haplotype H1 was absent in the samples of *B. manshuriensis* collected from China and Russia. Four haplotypes (H6, H7, H41 and H43) were shared by *B. manshuriensis* and *B. pacifica* (Table 14). Haplotype H11 was shared by geographically distant populations of three taxa: a population of *B. alopecuroides* from Mongolia, two populations of *B. pacifica* from Russian Far East and two populations of *B. major* var. *ovata* from Hokkaido. Two Korean accessions identified as *B. manshuriensis* shared one haplotype (H14) with a Korean sample identified as *B. alopecuroides*. One haplotype (H34) was shared by *B. major* var. *japonica* and a sample from Korea identified as *B. manshuriensis*.

(4) Phylogenetic analyses of the *B. manshuriensis* complex

The NJ tree based on six cpDNA regions is presented in Fig. 14. The NJ tree based on six cpDNA regions was highly similar to the tree based on three cpDNA regions (Fig. 14, 15). However, the number of haplotypes was reduced to 43 from 56 when only three regions were analyzed. Hence, to understand the phylogenetic relationships among the different taxa of the complex with more clarity, only three regions were selected for further phylogenetic analysis. The NJ analysis of combined cpDNA dataset of three regions (*trnK* + *matK* + *ndhF*) resulted in a single tree (Fig. 15). For bayesian analysis, MrModeltest was run which identified the following models of sequence evolution as optimal for the three cpDNA regions examined in this study; F81 for *trnK*, and GTR for *matK* and

Table 14. Distribution of cpDNA haplotypes among the populations of the *B. manshuriensis* complex and related species.

Popu-lation	Taxon/ Accession	Haplotypes																																										
		01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
B. manshuriensis																																												
M1	rs_kb1																				●																							
M2	rs_kh1–3																					●											●											
M3	rs_kh4–																					●											●											
M4	rs_kh32																					●																						
M5	rs_ot1																																									●		
M6	rs_ri1, 2						●																																					●
M7	cn_hj1									●																																		
M8	cn_hj2–4							●								●																												
M9	cn_hj5										●																																	
M10	cn_nm1				●																																							
M11	cn_ul1							●																																				
M12	cn_sb1, 2							●																																				
Korean individuals identified as *B. manshuriensis*																																												
M13	kr_od1	●																																										
M14	kr_jm1–3																																	●										
M15	kr_dg1									●																																		
M16	kr_dr1	●																																										
M17	kr_sw1, 2																												●															
M18	kr_hg1	●																																										
M19	kr_gy1	●																																										
M20	kr_nh1, 2																																		●									

Table 14. (Continued).

Population	Taxon/ Accession	Haplotypes																																										
		01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
M21	kr_gu1	●																																										
M22	kr_mp1	●																																										
M23	kr_bc1	●																																										
M24	kr_os1	●																																										
M25	kr_os2–5	●																●																									●	
M26	kr_sn1	●																																										
M27	kr_gn1, 2														●																													
M28	kr_bs1–3			●																																				●				
M29	kr_jn1	●																																										
M30	kr_bl1, 2	●																																				●						
M31	kr_jg1, 2	●																																							●			
M32	kr_mt1	●																																										
M33	kr_md1,																●																											
M34	kr_dn1, 2	●																																										
M35	kr_sm1, 2																				●																							
B. pacifica																																												
P1	rs_ms1–4											●							●																									
P2	rs_nk1, 2											●																																
P3	rs_pr1						●																																					
P4	rs_pr2, 3						●																																					●
P5	rs_rc1–3	●																																								●		
P6	rs_rc4–8	●																																					●					

Table 14. (Continued).

Population	Taxon/ Accession	Haplotypes																																										
		01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
P7	rs_us1, 2	●																																										
P8	rs_pr4						●																																					
P9	rs_pr5																																									●		
P10	cn_jl1, 2							●																																				
P11	cn_jl3, 4							●																																				
P12	cn_sn1, 2							●																																				
P13	cn_mc1,							●																																				
P14	kr_hw1, 2	●																																										
P15	kr_dm1–																										●																	
P16	kr_sk1–8								●											●																								
P17	kr_sh1																										●																	
P18	kr_gb1, 2	●																																										
P19	kr_gw1–3		●																	●																								
P20	kr_ck1, 2	●																																										
P21	kr_hc1	●																																										
P22	kr_hb1	●																																										
P23	kr_hb2	●																																										
P24	kr_mj1	●																																										
P25	kr_tb1,2	●																																										
P26	kr_tb3	●																																										
P27	kr_so1–6	●																																										
P28	kr_Il1	●																																										
P29	kr_mj1, 2					●																																						

Table 14. (Continued).

Population	Taxon/ Accession	Haplotypes																																										
		01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
P30	kr_dk1	●																																										
P31	kr_jr1	●																																										
P32	kr_jr2	●																																										
B. major var. *ovata*																																												
O1	jp_rb1											●																																
O2	jp_hk1–4											●											●																					
B. major var. *japonica*																																												
J1	jp_hn1, 2											●																																
J2	jp_ky1																																		●									
J3	jp_jp1												●																															
B. major var. *japonica*																																												
B1	cn_bj1																																			●								
B2	uk_1																																				●							
Korean individuals identified as *B. alopecuroides*																																												
A1	kr_gr1, 2	●																												●														
A2	kr_hl1–4																								●			●		●		●												
A3	kr_hl5–8																								●	●					●													
A4	kr_hl9																													●														
A5	kr_hl10–	●																						●		●																		
A6	kr_hl14														●																													
B. alopecuroides																																												
A7	mn_1													●																														
A8	mn_2											●																																

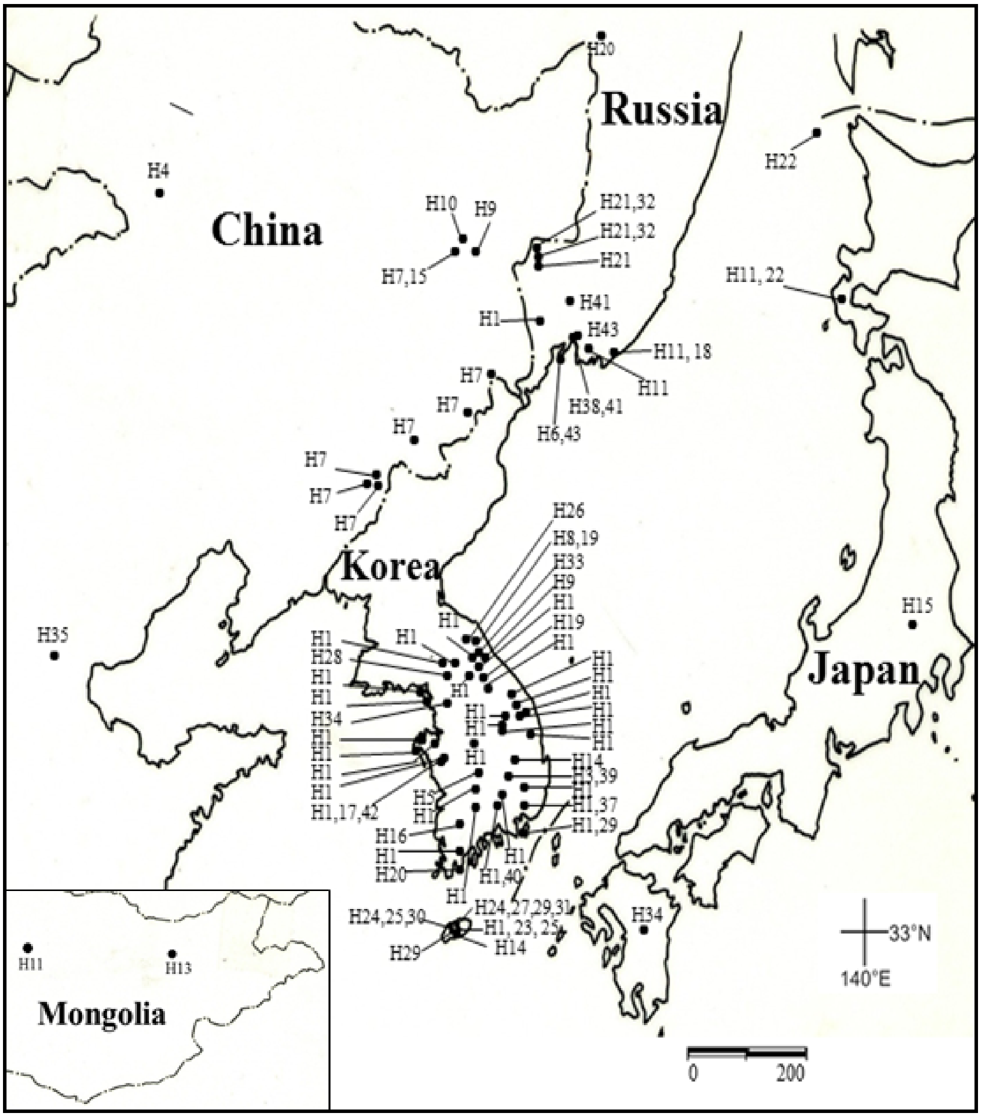

Fig. 13. Geographical distribution of 43 cpDNA haplotypes.

ndhF. The majority-rule consensus tree obtained from BI analysis of the combined cpDNA data set is shown in Fig. 16. The NJ tree and the bayesian majority-rule consensus tree were identical in topology and groupings. In both NJ and BI trees, the haplotypes of the *B. manshuriensis* complex were resolved as strongly supported monophyletic group (PP = 1; BS = 100%). However, none of the taxa of the complex were resolved as monophyletic group in the phylogenetic trees. The haplotypes were clustered into two major groups: a large lineage A consisting of 31 haplotypes and the small lineage B consisting of 12 haplotypes (Fig. 15, 16). In BI, lineage A was strongly supported (PP = 1) but poorly resolved, and consisted of samples representing all taxa within the complex and the related taxa. This clade consisted of haplotypes from *B. manshuriensis* of northeast China, most of the Korean individuals identified as *B. manshuriensis,* some individuals of *B. manshuriensis* from Khanka region, most of the individuals of *B. pacifica*, *B. alopecuroides* from Mongolia and the Korean indviduals identified as *B. alopecuroides*. Within lineage A, a group of haplotypes obtained from the samples of some Russian specimens of *B. pacifica*, Japanese individuals of *B. major* var. *ovata* and *B. major* var. *japonica* and a sample of *B. alopecuroides* from Mongolia formed strongly supported monophyletic group (PP = 1). Within lineage A, a group of haplotypes (H7, H8 and H10) consisted of individuals of *B. pacifica* and *B. manshuriensis* from northeast China and *B. pacifica* from Mt. Seorak of Korea (PP = 1).

Clade B was also strongly supported (PP = 1) and consisted of remaining accessions of *B. manshuriensis* of Lake Khanka region, Russia Island and Olenevad region, some individuals of Namhansanseong, Mt. Odae, Mt Biseul, Mt Jagul and

Mt. Oseo of Korea, *B. major* from China and UK, *B. major* var. *japonica* from Japan and *B. pacifica* from Russia. In clade B, haplotype H39 representing a diploid individual of *B. manshuriensis* with glabrous leaves formed a clade with haplotype H38 representing a tetraploid individual of *B. pacifica* having densely pubescent abaxial leaf surface (PP = 1). In addition, within lineage B, a strongly supported group (PP = 1) consisted of haplotype H34 including samples of *B. manshuriensis* from Korea and *B. major* var. *japonica* from Japan, and haplotypes H35 including an accession of *B. major* var. *major* sampled from China. Thus, the group consisted of accessions from different taxa sampled from geographically distant populations (Fig. 2, Table 2).

The other strongly supported monophyletic groups in the NJ and BI trees include; 1) a clade consisting of haplotypes H42 and H43 which consisted of samples identified as *B. manshuriensis* from Mt. Oseo and samples of *B. manshuriensis* and *B. pacifica* from Russia (PP = 1; BS = 100%), and 2) a group of haplotypes H30 and H31 oconsisting of accession identified as *B. alopecuroides* from Mt. Halla of Korea (PP = 1; BS = 95%).

(5) Haplotype network

To gain better insight into the relationships between the cpDNA haplotypes, a parsimony haplotype network was estimated (Fig. 17). The TCS network analysis (Clement et al., 2000) of the combined cpDNA sequence data matrix resulted in a single unrooted parsimony haplotype network. The network was calculated at a 95% connection limit of 27 steps. The outgroup taxa did not meet the 95% connection limit and were excluded from the analysis. The main network contained three contiguous groups corresponding to the clades recovered in the NJ and Bayesian phylogeny.

Multiple haplotypes detected from the same population were often distantly related as shown by the network (eg. Populations M6, M25, M28, M30, M31, M3, P4, P5, P6, A1; Table 2).

Fewer haplotypes occurred more than once in the samples collected in this study. Thus, a majority of haplotypes were population-specific. Some haplotypes were connected by a chain of six inferred haplotypes, suggesting fairly high genetic divergence between some haplotypes (Table 14, Fig. 17). Most populations were fixed for one haplotype, and most haplotypes were not shared among populations. The internal haplotypes H6, H7, H11 and H21 were separated from the most common haplotype of Korea (H1) by single mutation step. Meanwhile, the haplotypes detected in the individuals of *B. alopecuroides* distributed in Mongolia were separated from the haplotypes detected in morphologically similar Korean accessions identified as *B. alopecuroides* by at least two mutation steps. Some haplotypes were distributed in different taxa, for example, haplotype H1 was found in all taxa of the *B. manshuriensis* complex distributed in Korea, haplotype H7 was identified in all individuals of *B. pacifica* distributed in northeast China and most individuals of *B. manshuriensis* distributed in northeast China and Russian Far East, and haplotype H11 was found in both *B. major* var. *ovata* distributed in Japan and *B. pacifica* distributed in northeast China.

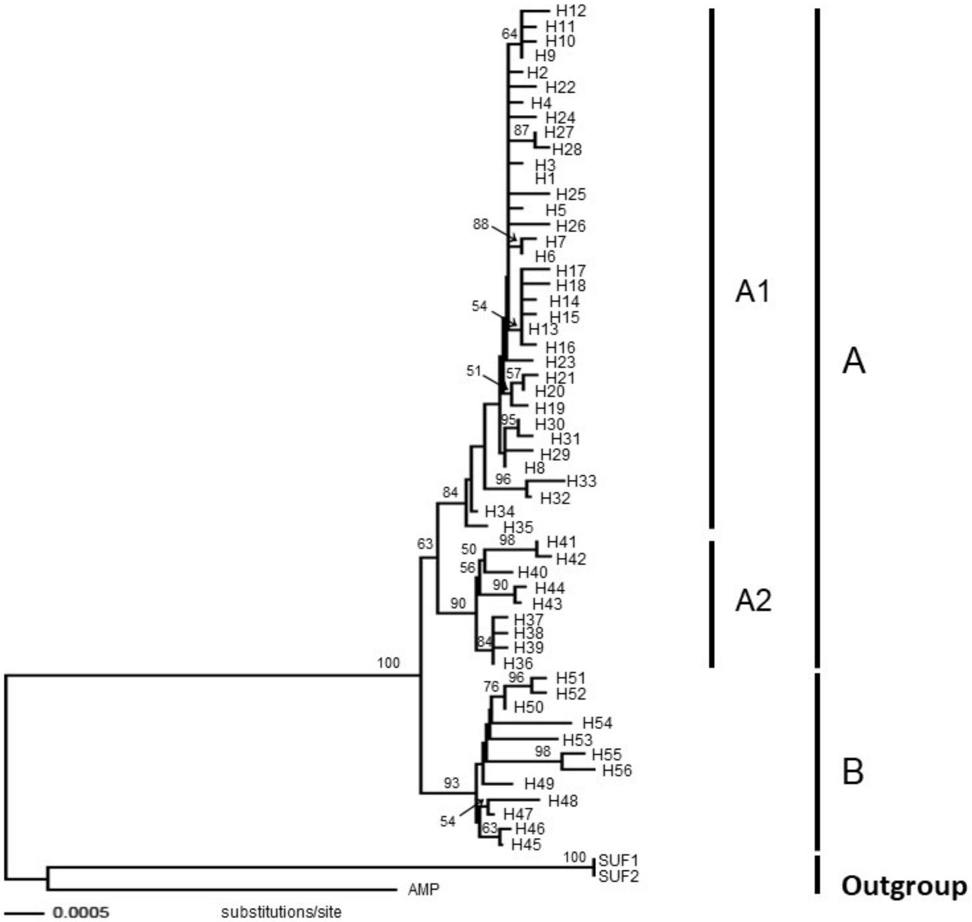

Fig. 14. A Neighbor Joining tree based on 56 haplotypes of the *B. manshuriensis* complex and related species inferred from six cpDNA regions. Numbers above branches are bootstrap values. M = *B. manshuriensis*, P = *B. pacifica*, A = *B. alopecuroides*, O = *B. major* var. *ovata*, B = *B. major* var. *major*, J = *B. major* var. *japonica.*

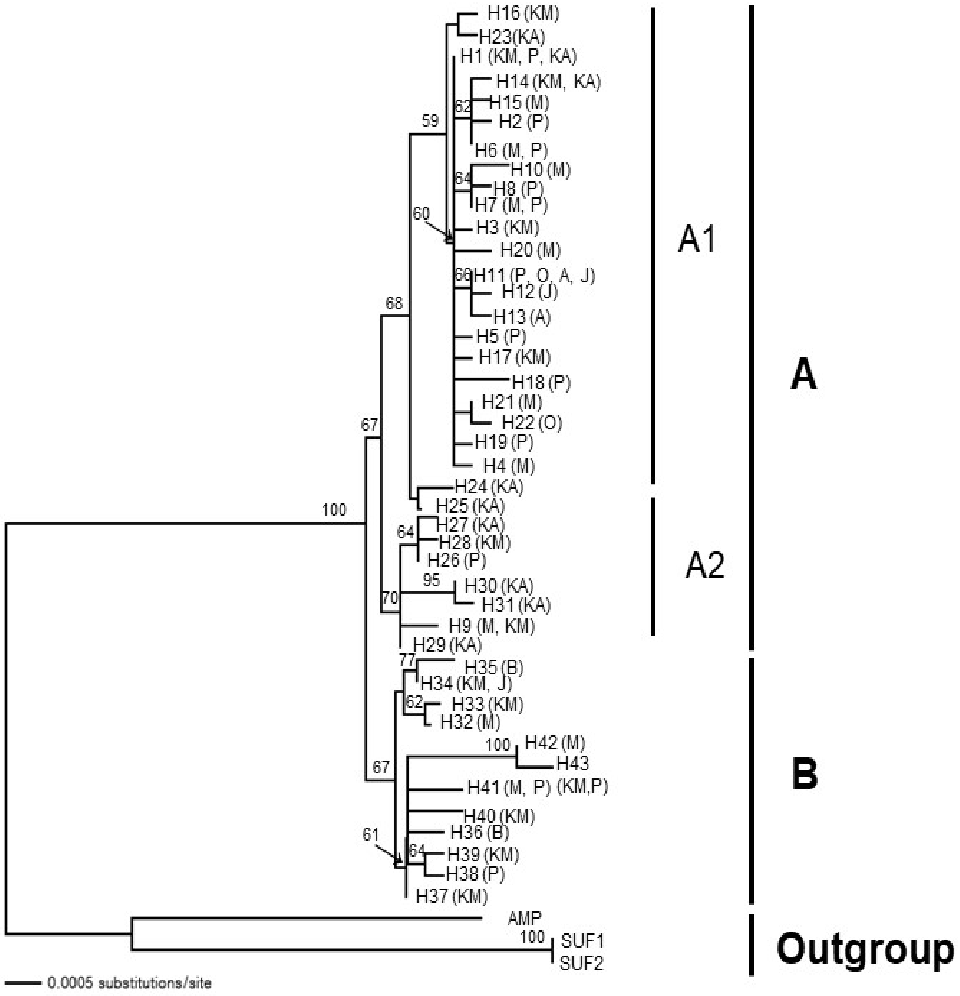

Fig. 15. A neighbor joining tree based on 43 haplotypes of the *B. manshuriensis* complex and related species based on six cpDNA regions. Numbers above branches are bootstrap values. A = *B. alopecuroides*, KA = Korean individuals identified as *B. alopecuroides*, M = *B. manshuriensis*, KM = Korean individuals identified as *B. manshuriensis*, P = *B. pacifica*, O = *B. major* var. *ovata*, J = *B. major* var. *japonica*, B = *B. major* var. *major*.

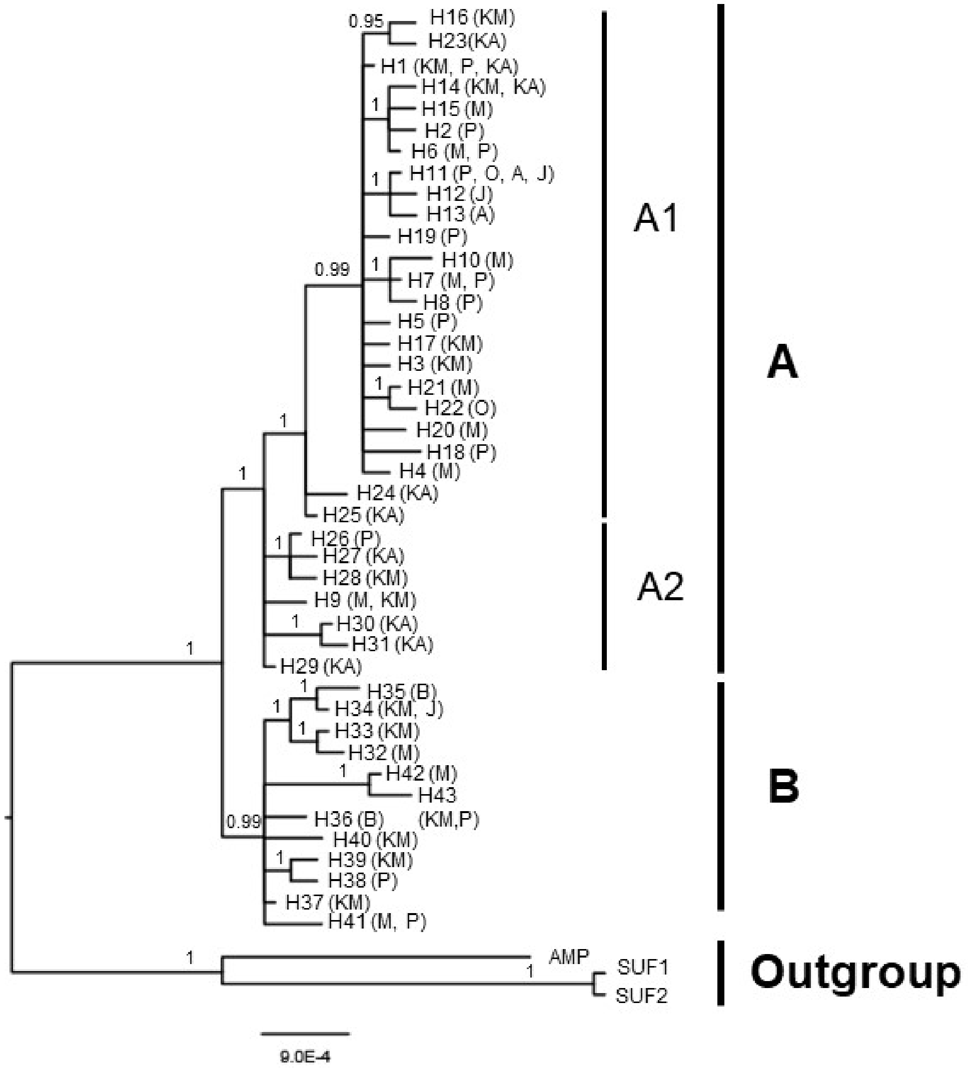

Fig. 16. A Bayesian inference tree based on 43 haplotypes of the *B. manshuriensis* complex and related species based on six cpDNA regions. Numbers above branches are posterior probabilities. A = *B. alopecuroides*, KA = Korean individuals identified as *B. alopecuroides*, M = *B. manshuriensis*, KM = Korean individuals identified as *B. manshuriensis*, P = *B. pacifica*, O = *B. major* var. *ovata*, J = *B. major* var. *japonica*, B = *B. major* var. *major*.

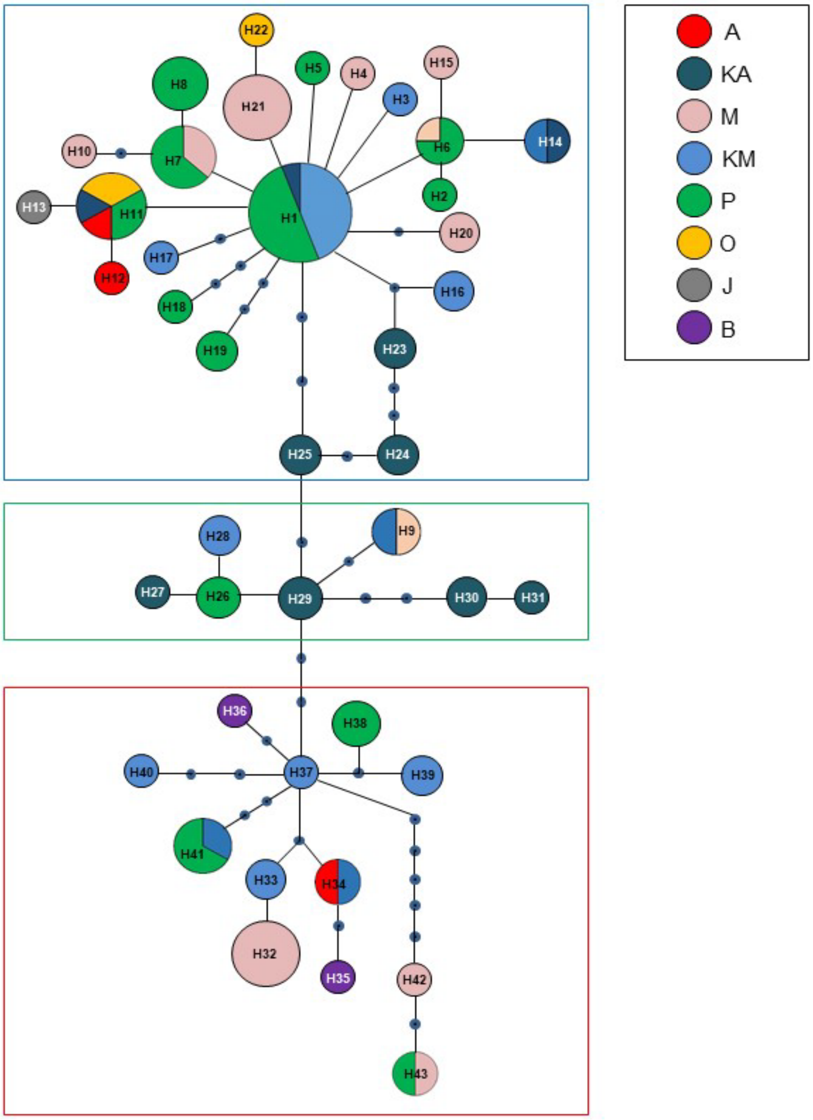

Fig. 17. TCS statistical parsimony network of the 43 cpDNA haplotypes detected in the *B. manshuriensis* complex and closely related taxa based on combined cpDNA dataset. Letters refer to haplotypes. The size of each circle reflects the number of samples with a shared haplotype. A = *B. alopecuroides*, KA = Korean individuals identified as *B. alopecuroides*, M = *B. manshuriensis*, KM = Korean individuals identified as *B. manshuriensis*, P = *B. pacifica*, O = *B. major* var. *ovata*, J = *B. major* var. *japonica*, B = *B. major* var. *major*.

IV. Discussion

Monophyly of the *B. manshuriensis* complex: Results from phylogenetic analyses of the nuclear and plastid combined data sets strongly support the monophyly of the *B. manshuriensis* complex (Fig. 11, 15). However, none of the taxa of the complex were supported as monophyletic in this study. The chloroplast data indicated a deep genetic divergence within the complex, resulting in two clades. However, the two clades did not correspond to the circumscription of species based on morphology. There was no obvious correlation between morphological and DNA sequence data. Moreover, results from the PCA showed that the taxa of the complex did not segregate distinctly. Thus, the result from morphological and molecular analyses did not support previous taxonomic treatments at the species levels based on morphology (Komarov, 1926, 1936; Nakai, 1938; Tzvelev, 1987). The result suggested that the morphological characters used to delimit the taxa were not useful for defining monophyletic groups. Though exons, introns and intergenic spacers of cpDNA were sequenced in this study with a total aligned length of 5785 bp, to utilize different rate of evolution of different regions for resolving phylogenetic relationship among the taxa of the complex, variation in the sequence data weakly resolved relationship among the taxa. Previous studies in *Aquilegia* (Hodges and Arnold, 1994) and *Lupinus* (Huang and Friar, 2011) have also shown that variation in chloroplast DNA sequences is sometimes insufficient to resolve the phylogenetic relationships in some plant group, even with large morphological divergence.

ITS polymorphisms: In phylogenetic studies at low taxonomic levels, ITS sequences have been found to provide greater level of divergence than cpDNA sequence (Baldwin et al. 1995; Sang et al., 1997; Soltis and Soltis 1998; Álvarez and Wendel, 2003). However, in the present study, ITS sequences showed lower level of overall divergence and lacked striking genetic differentiation observed in cpDNA. Analysis of ITS sequences showed that fifty seven of the 84 individuals analyzed in this study contained two or more ribotypes. All taxa of the *B. manshuriensis* complex were polymorphic and some individuals of the complex contained as many as seven ribotypes. The maximum number of ribotypes found in an individual in the *B. manshuriensis* complex was higher than the number found in other taxa of Polygonaceae (Kim and Donoghue, 2008; Wan et al., 2014). Intra-populational sequence divergence was relatively common in the complex. Among the 28 ribotypes found in the complex, eight were shared by two or more taxa of the complex. Ribotype R1 was found in all taxa of the complex which suggested their origin from a common ancestor.

Hybridization, long generation time and polyploidy are some of the main factors that account for ribotype polymorphism in plants. It is likely that these factors contributed to the intraindividual polymorphism that was detected in the taxa of the *B. manshuriensis* complex. Both interspecific and intraspecific hybridization events bring together different alleles from different parental sources into a single genome and therefore can give rise to intraindividual polymorphism (Koch et al., 2003). Clonal propagation through rhizome has been suggested in *B. officinalis* (Kostrakiewicz-Gierałt, 2013) and possibly occurs in the taxa of *B. manshuriensis* complex as ramets connected to the rhizome have been found in many instances in the field (pers. obs.). Clonal propagation leads to a longer generation time, which in turn reduces the rate of concerted evolution resulting in ribotype polymorphism (Sang et al., 1995). Similar results of high ribotype polymorphism has been demonstrated in *Carapichea ipecacuanha* which propagates clonally with infrequent sexual reproduction (Sousa Queiroz et al., 2011).

Polyploidization is another factor that could favor the maintenance of intraindividual polymorphism, because it is less likely that copies of nuclear DNA on different chromosomes will undergo homogenization than copies on the same chromosome (Campbell et al., 1997). Although the number of copies and chromosomal locations of nuclear DNA in the species of *Bistorta* are unknown, polyploidy has been found in some species including *B. officinalis and B. vivipara* (Doida, 1960; Löve, 1954; Löve & Löve, 1974; Goldblatt, 1988; Krogulevich & Rostovtseva, 1984; Krahulková, 1990). Hence, a majority of the taxa of the complex might contain nuclear DNA arrays in distinct locations within the genome retaining nuclear DNA polymorphism.

Haplotype polymorphisms: The taxa of the *B. manshuriensis* complex showed high level of within and among population variation in chloroplast sequences. Among 41 of 81 populations from which two or more accessions were sampled, eighteen (43.9%) contained multiple haplotypes. The number of haplotypes found in the *B. manshuriensis* complex was comparable to the number found in the circumpolar arctic-alpine herb *Oxyria digyna* (Allen et al., 2012), eventhough the latter was sampled from 140 localities compared to 81 localities sampled in this study.

TCS parsimony network analysis revealed that one haplotype (H1) was shared across three taxa and several other haplotypes were shared between two taxa. All taxa contain both shared and population-specific haplotypes. Haplotype sharing between closely related species has been found in a number of genera such as *Artemisia* (Shimono et al, 2013), *Betula* (Palme et al, 2003); *Achillea* (Guo et al., 2012). Sharing of different cpDNA haplotypes could be explained by i) interspecific gene flow, ii) ancestral polymorphism and incomplete lineage sorting and iii) mutation and allopatric divergence. The three explanations are not mutually exclusive and may act together. Firstly, previous phylogenetic studies among species using chloroplast DNA variations have shown that chloroplast captures occur frequently in many plant species groups (Rieseberg and Soltis, 1991). However, current hybridization between taxa of *Bistorta* is unlikely because accessions from populations with geographical proximity did not always form a monophyletic group and some clades in the phylogenetic tree consisted of accessions separated by large geographical distances. If hybridization is to be evoked for the explanation of the grouping of distant populations in clade B, gene flow may have occurred in remote past via seeds across a broad geographical scale. It is often difficult to distinguish hybridization from incomplete lineage sorting, as the cause of sharing of haplotypes at both scenarios produce a similar pattern of allele sharing (Wendel and Doyle, 1998; Muir and Schlotterer, 2005). Secondly, incomplete lineage sorting is a factor that complicates the use of cpDNA in phylogenies as it can be easily misinterpreted as evidence of interspecific gene flow (Schaal and Olsen, 2000). In the present study, haplotypes were also shared between distant populations of same or different taxon in the complex in some cases. Haplotype H1 and H7 was shared between the taxa of different ploidy level. In 18 of the 41 populations with multiple sampling, intrapopulation cpDNA polymorphism was detected. These results indicated persistence of ancestral haplotype polymorphism as a result of incomplete lineage sorting. There are several other examples where incomplete lineage sorting of ancestral polymorphisms has been identified as the most likely cause of the incongruence between cpDNA phylogeny and morphology (Lavin et al., 1991, Mayer and Soltis, 1994; Mason-Gamer et., 1995; Byrne et al., 2002). Thirdly, independent origin of haplotypes in isolated population due to mutation and allopatric divergence of populations in isolated microrefugia could also be responsible for relatively large number of population-specific cpDNA haplotypes. High number of population-specific haplotypes as a result of mutation in isolated refugia was suggested in several alpine plants of northeast Asia such as *Arcterica nana* (Ikeda and Setoguchi, 2006), *Cardamine nipponica* (Ikeda et al. 2008b) *Diapensia lapponica* subsp. *obovata* (Ikeda et al. 2008a). TCS stastistical parsimony analysis of cpDNA revealed that the *B. manshuriensis* complex contained both shared and population-specific haplotypes. Haplotype H1 was dominantly distributed in Korea. An ancestral haplotype is expected to occupy a central position within a haplotype network and consequently have more mutational connections to other haplotypes (Crandall and Templeton, 1993). Given that the frequent haplotype (H1) was in the central position of the network, H1 was the probable ancestral haplotype in the complex. Haplotype H1 was distributed in 31 populations in Korea and three populations in Russian Far East. The population-specific haplotypes were either divergent haplotypes or derived from shared ancestral haplotypes. Population-specific rare haplotypes may have diverged from the widespread haplotype H1 after colonization into each population as most of the population-specific haplotypes were separated from the most common haplotype by one or two mutation steps. The distribution pattern of haplotypes (Fig. 13) indicated when northern Japan, Russian Far East, northeast China and Korea were treated as separate regions, each region had usually region-specific haplotypes. For example, the common haplotype H1 was found in Korea and Russian Far East and haplotype H7 was restricted to the populations in northeast China only. Thus, haplotypes appeared to be distributed nonrandomly. Shared haplotypes were usually restricted to neighboring populations in each region, suggesting that the gene flow occurred mainly among the neighboring populations within the same geographic region (Fig. 13). Presence of region-specific haplotypes and few shared haplotypes among regions suggested genetic isolation of each region for long periods. Some adjacent populations, particularly in Russia, harbored divergent haplotypes (Fig. 13, 17). Majority of the populations were monomorphic containing single haplotype; although if more individuals per population were analyzed, more haplotypes might be detected.

Although seeds of the taxa in the *B. manshuriensis* complex lack morphological adaptation to long-distance dispersal, they are probably dispersed by birds similar to many other taxa of Polygonaceae (Croat, 1978). Most of the haplotypes had narrow distribution range. The populations carrying identical (shared) haplotypes were often located adjacently supporting the hypothesis of short-distance dispersal of seeds and restricted gene flow. The wide distribution of haplotype H1 indicated that the gene flow may have occurred via seeds to the current distribution area in the remote past indicating historical gene flow in once continuous ancestral population. Alternatively, the result may suggest occasional long-distance dispersal of seeds which is less likely given the wide distribution of only one haplotype.

Large number of unobserved haplotypes revealed by the haplotype network indicated severe population bottlenecks which resulted in the extinction of many intermediate haplotypes. This was more evident in Russian Far East where many diverging lineages were found. The results were consistent with the fact that the region lies in high latitude and may have experienced severe climatic fluctuations (Hewitt, 2004) during Pleistocene. This may have resulted in population bottlenecks and some populations survived in isolated microrefugia.

All populations of the *B. manshuriensis* complex sampled from high mountains near the border between China and Korea harbored haplotype H7 that was separated from the dominant haplotype (H1) by single mutation step (Fig. 17). The result suggested recent single introduction. Alternatively, the result could indicate population bottlenecks as the high mountains of the region was glaciated during the last Pliestocene glaciation (Kano, 1937; Kong and Watts, 1993; Shi, 2002) and the populations/species that occur in formerly glaciated regions usually show lower levels of genetic diversity than those from unglaciated areas as a result of founder effects or population bottlenecks (Hewitt, 1996; Jimenez et al., 2010; Widmer and Lexer, 2001).

Variation of the tetraploid complex: The individuals of *B. pacifica*, and *B. major* var. *ovata* and *B. alopecuroides* were tetraploid. However, even with the extensive sampling for chromosome counts, including 66 individuals in 53 populations, triploid (2*n* = 36) individuals were not found in this study suggesting that the diploid and tetraploid taxa are reproductively isolated and gene flow occurred between or among the taxa of the same ploidy level. Meanwhile, *B. major* var. *ovata* distributed in japan and *B. pacifica* were morphologically similar and were clustered together in multivariate analysis. An examination of type specimens of *B. pacifica* and *B. major* var. *ovata* deposited in LE and TI respectively indicated that the two taxa are morphologically similar. In PCA, Axis II separates *B. pacifica* weakly from the cluster of accessions from Korea and Russia recognized as *B. manshuriensis*. The major characters that contributed to Axis II were leaf blade length of basal leaf, position of the maximum width in leaf blade and length of petiole wing.

Many individuals of *B. pacifica* and all individuals of *B. major var. ovata* contained two or more ribotypes which resolved in different clades suggesting gene flow among the taxa. Meanwhile, two ribotypes (R10 and R11) were shared by some individuals of *B. pacifica* and *B. major* var. *ovata* only (Table 11). In addition, some individuals of *B. pacifica* from Russia and *B. major* var. *ovata* had identical haplotypes. The results from molecular, morphological and chromosome analysis, thus, supports the inclusion of *B. major* var. *ovata* in *B. pacifica*.

Variation of the diploid complex: The individuals of *B. manshuriensis* collected from Russian Far East and northeast China were diploids. An examination of the type specimens of *B. manshuriensis* deposited in LE revealed that the type specimens were heterogenous mixture of individuals with and without basal leaves. The lectotype, however, seems to actually represent *B. manshuriensis* since this specimen was proposed as the type specimen by original author (*nomen nudum* by Petrov). The lectotype of *B. manshuriensis* is morphologically similar to some specimens collected from Northeast China and Russian Far East for the present study, in having smaller rhizome, absence of basal leaves, thin papery and glabrous cauline leaves and auriculate sagittate base of middle and upper cauline leaves. These specimens, however, could not be included in PCA due to lack of basal leaves. DNA sequence analysis revealed the presence of one to two ribotypes in these individuals. In total, there were three ribotypes distributed in these individuals including the most common ribotype R1. The other two ribotypes were population-specific. In addition, Russian and Chinese individuals harbored nine cpDNA haplotypes. The general haplotype H1, which was commonly distributed in the Korean populations identified as *B. manshuriensis,* was absent in the Russian and Chinese populations of *B. manshuriensis*. Among nine haplotypes, two (H9 and H20) were shared with the Korean individuals identified as *B. manshuriensis*. Haplotype H9 was shared by a population (M7) in Northeast China and a population (M15) in Korea. Similarly, H20 was shared by a population (M1) in Russian Far East and a population (M35) in southern coast of Korea. The relatively larger geographical distance between these populations suggested retention of ancestral haplotype polymorphism by incomplete lineage sorting rather than hybridization. Thus, the result obtained from morphological and molecular data suggested that *B. manshuriensis* is distributed in Northeast China and Russian Far East and the Korean populations identified as *B. manshuriensis* actually represented a different taxon.

Bistorta manshuriensis was first reported in Korea by Nakai (1938). Many subsequent taxonomists supported the occurrence of *B. manshuriensis* in Korea (Park, 1974; Lee, 1980; Lee, 1996; Park and Hong, 2007). Lee (1996), however, recognized this species as *Bistorta major* var. *japonica*, excluding *B. manshuriensis* from the flora of Korea. The type specimens of *B. manshuriensis* deposited in LE clearly differ from Korean specimens in having smaller rhizome, absence of basal leaves, thin papery cauline leaves and auriculate sagittate base of middle and upper cauline leaves. The Korean specimens were morphologically more similar to Japanese specimens of *B. major* var. *japonica* collected for this study, and a thorough examination of the specimens including type specimens of *B. major* var. *japonica* deposited in TI further confirmed it. In PCA, the Korean specimens formed a cluster together with the specimens collected from Khanka region of Russia. This cluster was partially overlapped with the cluster of *B. pacifica* and *B. major* var. *ovata* on lower side of the plot as well as the Korean specimens recognized as *B. alopecuroides* on the left side. Axis I weakly separated cluster of the Korean individuals identified as *B. manshuriensis* and *B. alopecuroides*. The major characters that contributed Axis I were Leaf blade width at 1/3, 1/2 and 2/3 point of leaf blade, leaf blade width at the widest point and ratio between width and length of leaf blade.

Korean specimens identified as *B. manshuriensis* were diploids. The ITS sequence of all Korean individuals had overlapping peaks in electropherogram, and two to four ribotypes were recovered from each individual after cloning. In total, seven ribotypes were recovered from Korean individuals identified as *B. manshuriensis*. Among the seven shared ribotypes, five were shared with Korean specimens of *B. pacifca* and the specimens from Jeju Island identified as *B. alopecuroides*. Thus, the result suggested close relationship among Korean individuals of the *B. manshuriensis* complex. Thirteen cpDNA haplotypes were found in the Korean individuals identified as *B. manshuriensis*. Among thirteen haplotypes, only two haplotypes were shared with *B. manshuriensis*, one shared with an individual from China and the other shared with an individual from Russia. Nine of the thirteen haplotypes were population-specific suggesting a lower rate of gene flow via seeds. Taken together, the result suggested that the Korean individuals are morphologically and genetically distinguishable from *B. manshuriensis*. The Korean individuals are distinct from *B. pacifica* on the basis of chromosome number. Korean individuals identified as *B. manshuriensis* and *B. alopecuroides* were separable on the basis of morphology of basal leaves, though the two entities were genetically and cytologically close to each other.

Bistorta alopecuroides, originally described from Chita near lake Baikal, was first reported in Korea (Mt. Halla) by Nakai (1938). The occurrence of *B. alopecuroides* in Mt. Halla was also reported by later taxonomists (Park, 1974; Lee, 1980; Lee, 1996; Park and Hong, 2007). Lee (1996), however, recognized *B. major* var. *angustifolia* from Mt. Halla and Yonekura (2006) suggested that the individuals of Mt. Halla represent *B. officinalis* subsp. *japonica*. Based on field collections of *B. alopecuroides* from Mongolia and Mt. Halla of Jejudo and a comparison with the type specimens deposited at LE, it was found that the individuals of Mt. Halla differ remarkably from *B. alopecuroides* in several characteristics such as plant height, stem diameter, shape and size of basal and cauline leaves leaf pubescence, and inflorescence length. Moreover, in the chromosome counts carried out in the present study, the individuals of Mt. Halla were found to be diploids (2*n* = 24) compared to tetraploid (2*n* = 48) individuals of *B. alopecuroides* sampled from Mongolia. Two ribotypes were identified in each of the two specimens sampled from Mongolia, one was the common ribotype R1 shared across the taxa of the complex and the other (R13) was shared with two individuals from two populations of *B. pacifica* from Russia and an individual of *B. major* var. *ovata* sampled from Hokkaido, Japan. Thus, except the general ribotype R1, other ribotypes were not shared between *B. alopecuroides* and the individuals of Mt. Halla identified as *B. alopecuroides*. Similarly, one cpDNA haplotype (H11) was shared with two populations of each of *B. pacifica* and *B. major* var. *ovata* and a population of *B. major* var. *japonica*. Haplotypes were not shared between Mongolian individuals of *B. alopecuroides* and Korean individuals identified as *B. alopecuroides*. Thus, the individuals of *B. alopecuroides* collected from Mongolia showed higher affinities to *B. pacifica*, *B. major* var. *japonica* and *B. major* var. *ovata*, rather than individuals of Jeju Island identified as *B. alopecuroides*. Thus, Jeju populations were morphologically, cytologically and genetically distinguishable from *B. alopecuroides*.

V. Conclusion

This is the first molecular phylogenetic study to include comprehensive sampling of the taxa of the *B. manshuriensis* complex and related taxa from most of their range of distribution. The result of comparative analysis including PCA showed that *B. manshuriensis*, *B. pacifica* and *B. alopecuroides* were separated weakly based on leaf length, leaf shape and maximum width of basal leaves.

The ITS tree and cpDNA tree based on combined data revealed that the *B. manshuriensis* complex is monophyletic (PP = 1.0, BS = 100%). Multiple ribotypes and haplotypes were found in each taxon of the complex. Some of the taxa of the complex had shared haplotypes and ribotypes. Some individuals of the taxa had two or more ribotypes which resolved in different clades suggesting occurrence of gene flow among the taxa and populations of the complex. The results suggested that the taxa of the complex originated from a common ancestor and due to the persistence of ancestral haplotype polymorphism as well as hybridization lead to the complex relationship within the species complex.

On the basis of chromosome numbers, the individuals of *B. pacifica* were clearly distinguishable from *B. manshuriensis* distributed in China and Russia as well as Korean individuals identified as *B. manshuriensis* and *B. alopecuroides*. However, even with the extensive sampling including 66 individuals in 53 populations, triploid ($2n = 36$) individuals were not found suggesting that the diploid and tetraploid taxa are reproductively isolated and gene flow occurred between or among the taxa of the same ploidy level. Meanwhile, *B. major* var. *ovata* distributed in japan and *B. pacifica* had identical ploidy level and were also indistinguishable from each other based on morphological analysis. In addition, some individuals of *B. pacifica* from Russia and *B. major* var. *ovata* had identical haplotypes. The results from molecular, morphological and chromosome analysis, thus, supports the inclusion of *B. major* var. *ovata* in *B. pacifica*. Meanwhile, although, the individuals of *Bistorta* distributed in Mt. Seorak were very similar to the individuals of *B. pacifica*, they are distinguishable by relatively narrow lamina of basal leaves, curved basal and cauline leaves with undulate margin and the presence of linear second cauline leaf from the top. Moreover, the individuals were diploids (2*n* = 24) which warrant their recognition as a new species.

The Korean individuals identified as *B. manshuriensis* were found morphologically distinct from the type specimens of *B. manshuriensis* deposited in LE, but rather more similar to the type specimen of *B. major* var. *japonica* deposited in TI. It appears to be more to treat he Korean individuals, previously identified as *B. manshuriensis* as *B. major* var. *japonica*. The type specimen deposited in LE was morphologically identical to some diploid individuals collected from Northeast China and Russian Far East for this study. Relatively large number of cpDNA haplotypes recovered from these individuals, however, did not form monophyletic group in the phylogenetic tree. The result indicated that the speciation in *B. manshuriensis* a complex evolutionary process involving incomplete lineage sorting, hybridization and introgression as well as geographical divergence.

The individuals of *B. alopecuroides* and the Korean individuals recognized as *B. alopecuroides* had different chromosome numbers and possessed different cpDNA haplotype and ribotypes. The result suggested that Korean populations recognized as *B. alopecuroides* actually represent a distinct taxon.

On the bases of these results, three species and two subspecies, including one new species, were recognized in the complex in northeast Asia and description of all taxa and keys to the taxa are provided.

VI. Taxonomic treatment

Bistorta (L.) Scop., Meth. Pl. 24, 1754.

Polygonum [unranked] *Bistorta* L. Sp. Pl. 360, 1753. *Polygonum* sect. *Bistorta* (L.) D. Don, Prodr. Fl. Nepal. 69, 1825. *Polygonum* sect. *Persicaria* subsect. *Bistorta* (L.) Benth. & Hook. f., Gen. Pl. 3: 98, 1880. Lectotype: *Polygonum bistorta* L. (≡ *Bistorta officinalis* Delarbre), designated by Haraldson, Symb. Bot. Upsal. 22: 75, 1978.

Korean name: Beom-Kko-ri-Sok (범꼬리속)

Herbs, rarely subshrubs, perennial, monoecious or dioecious, rhizomatous; rhizomes thickened, short and tortuous or elongated and moniliform to thin, ligneous and stoloniferous, fleshy or woody, usually white or reddish white in the cross section. Stems erect or ascending, or [rarely prostrate], usually simple, terete, glabrous. Leaves basal [=radical] and cauline, basal leaves rosette, simple; leaf blade membranous or coriaceous, linear, lanceolate, elliptic to ovate, apex obtuse or acute to acuminate, cuneate or truncate to cordate at base, pinnately veined, margin entire or obscurely and irregularly undulating, revolute or flat, with or without thickened veins at margin, glabrous to densely pubescent at lower surface, long petiolate, not articulated, petiole winged near junction with blade or unwinged; cauline leaves alternate, simple, lower cauline leaves petiolate, middle and upper ones sessile and weakly or strongly amplexicaul, lower cauline leaves disintegrating with age; ocreae of lower cauline leaves broadly rounded, green basally, brownish distally, chartaceous, completely surrounding the nodes, oblique at apex, sometimes lacerate, eciliate at margin, ochrea of upper leaves truncate at apex. Inflorescences usually terminal or rarely terminal and axillary, simple or rarely branched, spike-like, mostly compact, globose to cylindrical in outline, consisting of monochasia (helicoid cymes), rarely bearing bulbils in lower part; each cyme 1–5-flowered, closely spaced and more or less compact, subtended by a bract; bracts ovate or lanceolate, scarious, entire or toothed at margin, eciliate; pedicels articulated at base of perianth, bearing paired scarious bracteoles. Flowers bisexual or unisexual; perianth deeply rarely 4- or 5-parted, deep red or pink, white to whitish-green; tepals subequal, mostly persistent, not accrescent in fruit; stamens 8, inserted at the base of perianth in one or two whorls, included or exserted, filaments white, flattened; nectaries of two kinds: outer ones free (sometimes absent), inner ones fused with the filament bases. Style 1, 2- or 3-cleft, 3–4 mm long, exserted; stigmas 2 or 3, very small, minutely capitate. Achenes trigonous or rarely biconvex, included or exserted, brown ro black, shiny or dull, smooth, tuberculate. Chromosome number $2n = 24, 48$.

Species ca. 50 (9 in Korea).

Distribution: Mostly in temperate to alpine regions of Northern Hemisphere.

Bistorta [(L.) Scop.] is a taxonomically difficult genus that includes approximately 30 to 50 species worldwide (Yonekura and Ohashi, 2001; Li et al., 2003; Freeman and Hinds, 2005; Galasso et al., 2009). The defining features of the genus *Bistorta* are perennial habit, stout and contorted rhizome; presence of basal leaves, revolute leaf margin with broad nerves on the edges, long, cylindrical and oblique ochrea, terminal and/or axillary spike-like cyme with dense flowers, 5-parted perianth, presence of eight free stamens, nectaries united with the base of inner stamens and tricolpate type of pollens (Greene, 1904; Hedberg, 1946; Haraldson, 1978; Ronse Decrane and Akeroyd, 1988). In Korea, about 9–11 species of *Bistorta* have been reported, one of them being endemic. The species of *Bistorta* have complex pattern of variation in morphology depending on geography and environment. Due to the continuous variation in morphological characters in some taxa, their taxonomic status, taxonomic boundary and ranking are controversial among the authors (Nakai, 1938; Park, 1974; Lee, 1980; Lee, 1996; Lee, 1996).

The *Bistorta manshuriensis* species complex includes closely related and controversial taxa: *B. manshuriensis* (Petrov ex Kom.) Kom. ex Nakai, *B. pacifica* (Petrov ex Kom.) Kom. ex Nakai and *B. alopecuroides* (Turcz. ex Besser) Kom. and two taxa from Japan supposed to be closely related to the complex: *B. major* var. *japonica* (H. Hara) Yonek. and *B. major* var. *ovata* Nakai ex H. Hara. The species of the complex have been circumscribed either in series or in section *Bistorta* (Komarov, 1936; Tzvelev, 1987; Yonekura, 2006). The Korean members of the complex are mainly distinguished on the basis of size and shape of leaf blade, broadness of petiole wing, tepal color. However, there is complex pattern of morphological variation among the species and some groups are characterized by intermediate morphological characters. Hence, it has been difficult to delimit species boundary and to clarify relationships between the closely related taxa of different geographical region.

Detailed study of herbarium specimens (including type specimens), field visits, protologues, taxonomic literature, principal components analysis (PCA), and chromosome counts has allowed to revise taxonomy of the species of the *B. manshuriensis* complex in this study. The species treated here have been primarily circumscribed by unique combination of basal leaf characters. Chromosome counts and DNA sequence data provided additional support for species circumscription. In some cases, a comparison with type specimens was performed. Many of the characters used by former authors to delimit taxa of the complex turned out to be highly variable with some characters seen as not suitable for species delimitation. In general, consistency in shape and size of radical leaf as well as chromosomal numbers was found to discriminate between species. On the basis of this study, four species and two subspecies were recognized in the *B. manshuriensis* complex in northeast Asia and the description of all taxa and keys to the taxa are presented.

Key to the species of the *Bistorta manshuriensis* complex

1. Basal leaves lanceolate, oblong, triangular to narrowly ovate, base cuneate, truncate or subcordate, middle and lower cauline leaves lanceolate.
    2. Basal leaves usually absent, leaves papery, glabrous, veins on the leaf margins not distinctly thickened …..……………..… 1. *B. manshuriensis*

2. Basal leaves always present, leaves membranous, glabrous or pubescent abaxially, veins on the leaf margins usually distinctly thickened.
    3. Basal leaves lanceolate oblong, triangular to narrowly ovate ………………...……………….….….……..2. *B. officinalis*
    3. Basal leaves lanceolate to oblong ………. 3. *B. alopecuroides*

1. Basal leaves narrowly to widely ovate, base cordate, middle and lower cauline leaves ovate to lanceolate.
    4. Basal leaves widely ovate, second cauline leaf from the top lanceolate or ovate, leaf blade glabrous or pubescent …………...…….. 4. *B. pacifica*
    4. Basal leaves narrowly ovate, second cauline leaf from the top linear, leaf blade glabrous …………..…..……………………….….…... 5. *B. koreana*

Species description

1. ***Bistorta manshuriensis*** (Petrov ex Kom.) Kom. ex Nakai, J. Jap. Bot. 14: 737, 1938.

Polygonum manshuriense Petrov ex Kom., Bot. Mater. Gerb. Glavn. Bot. Sada S.S.S.R. 6: 3, 1926. Type: China. Manshuria: "Ninguta, in pratis ad trajectum Loe-lin non procul a pago Taimagou", 13 Jul 1896, *Komarov s. n.* (lectotype: LE [not seen]); Russia. "Chabarovsk in pratis humidiusculis", 12 Jul 1902, *N. Desoulavy 153* (syntype: LE [not seen]); "ad sinus Chadshi-bai, Sovietscaja nuncdicta, 40 km, a litus mar. in pratis ripariis secus fl.", without date, *N. P.*

Krylov s. n. (syntype: LE [not seen]); "in valle fl. Botscha (48° lat. s.) in pratincolis silvaticis" 28 Jul 1924, *I. K. Schischkin* 122 (syntype: LE [not seen]); "ad fontes fl. Botscha in pratis subalpinis supra limites arborum", 30 Aug 1924, *I. K. Schischkin 564* (syntype: LE [not seen]).

Korean name: Man-ju-beum-kko-ri (만주범꼬리)

Rhizomes ca. 0.5 cm in diam. Stems usually 1, sometimes 2. Leaves: basal leaves absent; cauline leaves membranous, glabrous, lanceolate, acuminate at apex, bases cuneate, decurrent along petiole forming narrow or wide wings, veins not distinctly thickened at margin, upper cauline leaves strongly amplexicaul, auriculate, base cordate, subsessile, uppermost cauline leaf filiform or lanceolate; ocrea 3–12.3 cm long, glabrous. Inflorescences terminal, 3.5–7.5 cm long, ca. 0.8–1.2 cm in diam.; helicoid cymes 2- or 3-flowered, closely spaced; bracts narrowly ovate to elliptic, 2–3 mm long, membranous, translucent, cuspidate at apex. Flowers pink, tepals elliptic, rounded at apex; ca. 2.4 mm; stamens exserted; filaments 2.8 mm long, anthers dark brown; style 3-cleft at base, exserted. Achenes orbicular in outline, ca. 3 x 2 mm, enclosed, dark brown, sharply trigonous, shiny. Chromosome number: $2n = 24$.

Flowering Jun to Aug.

Distribution: northeast China, Russian Far East.

Bistorta manshuriensis was first reported in Korea by Nakai (1938), who was followed by subsequent Korean authors (Park, 1974; Lee, 1980; Lee, 1996; Park and Hong, 2007). Some Korean authors, however, did not recognize this species as part of the Korean flora (Chung, 1957; Lee, 1996). The type specimens of *B. manshuriensis* deposited in LE clearly differ from Korean specimens in having smaller rhizome, absence of basal leaves, thin papery cauline leaves and auriculate sagittate base of middle and upper cauline leaves. The type specimens are similar to the specimens collected from northeast China and Russian Far East in present study. Moreover, the type specimens appear to be heterogenous comprising highly dissimilar specimens. The lectotype, however, seems to correctly represent *B. manshuriensis*. The Korean specimens are more similar to Japanese specimens of *B. major* var. *japonica* and an examination of the type specimen of *B. major* var. *japonica* deposited in TI further confirmed it. Hence, *B. manshuriensis* is excluded from the Korean flora, and Korean specimens identified previously as *B. manshuriensis* are transferred to *B. major* var. *japonica* (≡ *B. officinalis* subsp. *japonica*) in this study.

Additional specimens examined: CHINA. Heilongjiang: Mudanjiang, Hailin, Changting town, Shuangfeng Forest Farm, China's snow town, 20 Jul 2015, *G. S. Bhandari & T. Y. Choi 3–7* (SNU); Mt. Bonghwa, 20 Jul 2015, *G. S. Bhandari & T. Y. Choi 9–11, 13-1, 13-2, 14, 15-1, 15-2, 16–19, 22-1, 22-2, 23, 24-1, 24-2, 28, 29, 39-1–39-4, 40, 42-1–42-4* (SNU); 11 Jul 2016, *C. W. Park & T. Y. Choi 74–83* (SNU); Harbin, Shangzhi, San Hao Tun, 21 Jul 2015, *G. S. Bhandari & T. Y. Choi 46, 47* (SNU). Jilin: Yanbian, Helong city, 24 Jul 2014, *T. Y. Choi 35–45* (SNU);

Ussullin, 11 Jul 2016, *C. W. Park & T. Y. Choi 23, 25–35* (SNU); Seonburyeong, 12 Jul 2016, *C. W. Park & T. Y. Choi 60–73* (SNU).

RUSSIA. Primorsky territory: Russia Island, 3 km to the north from Cape Vyatina, 15 Jul 2014, *C. W. Park & T. Y. Choi 32–40* (SNU); Between Olenevad and Tikhoye, 16 Jul 2014, *C. W. Park & T. Y. Choi 54, 55* (SNU).

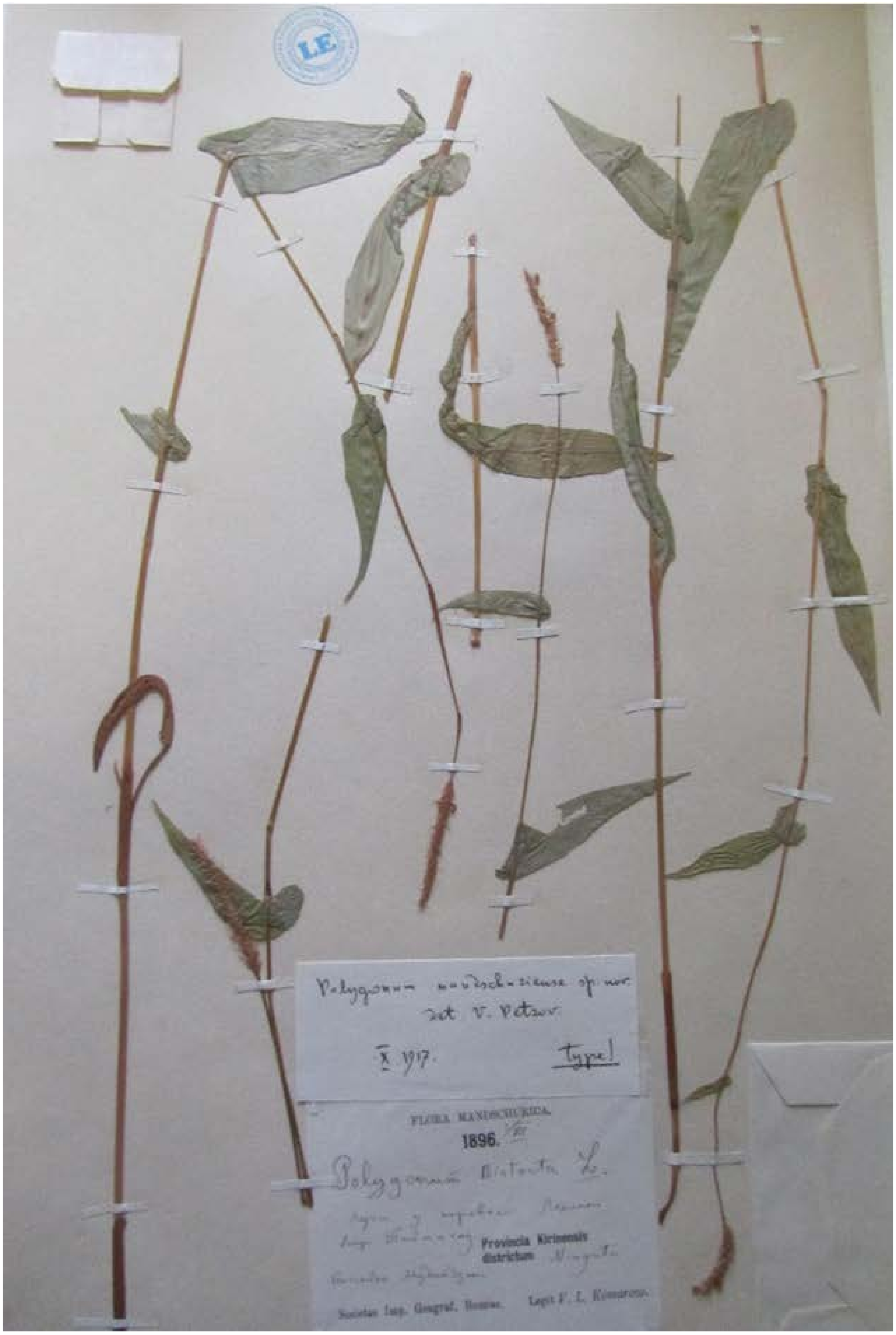

Fig. 18. Lectotype of *B. manshuriensis* (Petrov ex Kom.) Kom.

2. ***Bistorta officinalis*** Delarbre, Fl. Auvergne, ed. 2, 2: 516, 1800.

Polygonum bistorta L. Sp. Pl. 360, 1753. *Bistorta major* S. F. Gray, Nat. Arr. Brit. Pl. 2, 267, 1821. *Bistorta vulgaris* Hill, Brit. Herb. 488, pl. 70, fig. 10, 1756 (*nom. Illeg.*). Type: without specific locality and date, *Col?* (lectotype LINN 510.3).

Herbs 20–140 cm tall. Rhizomes 0.5–2 cm in diam. Stems usually 1–10. Leaves basal and cauline, glabrous to abaxially pubescent, membranous; basal leaves petiolate, blade lanceolate to ovate, 6–34 x 0.4–9.8 cm, acuminate at apex, base cuneate, truncate to subcordate, decurrent along petiole forming narrow or wide wings, petiole 3–48 cm long; lower cauline leaves lanceolate, base cuneate, upper ones subsessile, amplexicaul and auriculate or not amplexicaul, uppermost leaf lanceolate, linear to filiform; ocrea ciliate to eciliate. Inflorescences terminal, compact, 1.5–12.5 cm long, 0.6–1 cm in diam.; helicoid cymes 2–5-flowered, closely spaced; bracts oblong, ca. 4 mm long, membranous, cuspidate at apex. Flowers white; tepals elliptic, obtuse at apex; stamens exserted; style 3-cleft at base. Achenes ovate or orbicular in outline, slightly exserted, dark brown, shiny. Chromosome number $2n = 24, 48$.

1. Plants 75–140 cm tall, stems 1–5, basal leaves broadly lanceolate to ovate, base cuneate, truncate to subcordate ……...………… 2a. subsp. *japonica*
2. Plants 24.5–78 cm tall, stem 3–10, basal leaves lanceolate, base cuneate ………………………..……………...…..….. 2b. subsp. *angustifolia*

2a. subsp. *japonica* (H. Hara) Yonek., Fl. Jap. (Iwatsuki et. al., eds.) 2a: 145, 2006.

Bistorta major var. *japonica* H. Hara, J. Fac. Sci. Univ. Tokyo, Sect. 3, Bot. 6: 35, 1952. *Polygonum bistorta* L. subsp. *japonicum* (H. Hara) T. Shimizu, New Alp. Fl. Jap. Col. 2: 357, 1983. Type: Honshu, Prov. Shimotsuke, Nikko, without date, *Matsumura s. n.* (holotype [not seen]).

Polygonum bistorta L. var. *angustifolium* Nakai, J. Coll. Sci. Imp. Univ. Tokyo 23: 13, 1908, not Meisn. (1856). Type: Korea. Kyong-geui: insula Shakuyaku circa Inchon, 31 Oct 1900, *T. Uchiyama s. n.* (holotype: TI [not seen]).

Bistorta vulgaris Hill var. *nitens* Nakai, Rigakkai 24: 295, 1926.

Korean Name: Beum-kko-ri (범꼬리)

Herbs 75–140 cm tall, rhizomes 0.8–2 cm in diam., blackish brown. Stems 1–5, unbranched. Leaves basal and cauline, usually membranous, glabrous or rarely abaxial surface hairy; basal leaves long petiolate, blade lanceolate to narrowly ovate, 12.5–34.1 x 1.7–9.8 cm wide, acuminate at apex, bases cuneate, truncate to subcordate, decurrent along petiole forming narrow or wide wings, entire at margin, revolute, veins may or may not be thickened at the margin, upper surface green, lower surface grayish green, petiole 17–48 cm long; cauline leaves lanceolate, upper ones sessile, amplexicaul, auriculate, base truncate to cordate, uppermost cauline leaf linear or filiform; ocrea cylindrical, 3–13.5 cm long, lower part green, upper part brown, membranous, oblique at apex, usually with short crispy hairs along the veins, often cleft to middle. Inflorescence terminal, compact, 3.5–11.8 cm long, ca. 1 cm in diam.; monochasia 1–5-flowered, closely spaced; bracts ovate, 3.5–4 mm long, membranous, cuspidate at apex; pedicels 4–5 mm long, articulate at apex. Flowers white; tepals elliptic, obtuse at apex, ca. 3 x 1.5 mm; stamens 8, exserted; filaments 3.5–4 mm long; style 3-cleft at base, exserted; stigmas 3, capitate. Achenes sharply trigonous, ovate in outline, 2.5–3.8 mm long, 1.5–2.5 mm wide, slightly exserted, dark brown, shiny. Chromosome number $2n = 24, 48$.

Flowering May to Aug.

Distribution: Japan, Korea.

Korea: All provinces except Jeju.

B. major var. *japonica* was reported in Korea by Lee (1996). In the present study, it was found that the Korean individuals identified as *B. manshuriensis* clearly differ from *B. manshuriensis* in having larger rhizome, presence of basal leaves, and distinctly thickened veinlets in the leaf margin. Korean individuals identified as *B. manshuriensis* are similar to *B. major* var. *japonica* in having glabrous, lanceolate or narrowly ovate basal leaves gradually tapering towards the apex. The results of the present study supported that *B. major* var. *japonica* is the part of the Korean flora (Lee, 1996).

Additional specimens examined: JAPAN. Hokkaido: Mt. Rausudake, Rauso-cho, Menashi-gun, 10 Aug 1974, *K. Tsuchiya 1102* (TI). Honshu: Nikko, 1931, *col.?* (TI); Nikko, 1 Aug 1877, *Col.?* (TI); Kyozan, 04 Oct 1879, *Col.?* (Type, TI 02733); Hiroshima, Shobara-shi, Kumano, at the summit of Mt. Ryu-o-zan, 11 Jul 2012, *Y. Kadota 123029* (TNS); Gifu, Sakauchi-mura, Ibi-gun, 8 Jun 1983, *H. Takahashi & H. Takano 7791* (TNS); Aomori, Nishitsugaru-gun, Iwasaki-mura, Mt. Mukaishirakamidake, 13 Jul 1975, *Ohba et al.* (TI). Kyushu: Ohita, Hokkein-onsen, northeast side of Mt. Kuju-san, Naoir-gun, 25 Jul 1970, *M. Shimizu & F. Maeda s. n.* (HUH).

KOREA. Hamnam: Usuryeong, 16 Aug 1935, *T. Nakai 15377* (TI [2 sheets]); on the way from Adeokryeong (Pyeongbuk) to (Jangjin) Hamnam, 6 Jul 1914, *T. Nakai s.n.* (TI). Gangwon-do: Pyeongchang-gun, Daegwanryeong-myeon, Mt. Odae, Jingogae, 19 Jun 2009, *G. S. Bhandari 101–116* (SNU); 7 Jun 2015, *H. J. Suh & G. S. Bhandari 1–4* (SNU); Mt. Odae, Jilmaenuf, 23 May 2015, *H. J. Suh 1–5* (SNU); 2 Jun 2015, *G. S. Bhandari 1562-1–1562-4* (SNU); 1 Jul 2016, *H. J. Suh & G. S. Bhandari 1671-52–1671-59* (SNU); Mt. Odae, Daegwanryeong, 7 Jun 2015, *H. J. Suh & G. S. Bhandari 11–15, 20–22* (SNU); Mt. Odae, Gyejangmaul, 7 Jun 15, *H. J. Suh & G. S. Bhandari 5–10, 23* (SNU); Yeongwol-gun, Yeongwol-eup, Yeongheung-ri, Mt. Bongnae, 6 Sep 2010, *G. H. Nam et al. SHY984* (KB); Yeongwol, Mt. Sambang, 9 Aug 2001, *W. T. Lee s. n.* (KNU); Bukryeong, Mt.

Chheongye, 7 Jul 1974, *W. T. Lee s. n.* (KNU); Chuncheon-si, Dongnae-myeon, Goeun-ri, Mt. Daeryeong, 10 Aug 1975, *W. T. Lee s. n.* (KNU [3 sheets]); 3 Sep 2011, *G. S. Bhandari & K. H. Kim 110903-51, 110903-52* (SNU). Gyeonggi-do: Pocheon-si, Naechon-myeon, Mt. Suwon, 17 Jul 2015, *G. S. Bhandari 150717-1–15717-7* (SNU); 11 Jul 2016, *G. S. Bhandari 16711-1, 2, 4, 10, 11, 13* (SNU); Gwangju-si, Namhansanseong, 15 Jul 2012, *G. S. Bhandari 120715-1,120715-2* (SNU), 24 Jul 2016, *G. S. Bhandari 16724-1, 16724-2* (SNU), 4 Jul 1986, *Y. D. Kim s.n.* (SNU); Mt. Yongmun, 6 Jun 1972, *D. W. Lee s. n.* (SNU); Icheon-si, Baeksa-myeon, Songmal-ri, Wonjeokbong, 21 Jun 2007, *G. Y. Chung ANH-en-07621-004* (KB); Mt. Chheongye, 17 Sep 1977, *W. T. Lee s. n.* (KNU). Incheon: Jakyak-do, 31 Jul 1900, *Uchiyama s. n.* (TI [2 sheets]); 30 Oct 1900, *Uchiyama s. n.* (TI). Ganghwa-do, 10 Jun 1936, *Toh & Shim s. n.* (SNU 1449). Incheon: Ganghwa-gun, 10 Jun 1936, *Toh & Shim s.n.* (SNU 1449); Mt. Hyeolgu, 29 Jun 2007, *J. K. Eo & E. H. Lee s. n.* (KB); 1 Jul 11, *J. H. Park & K.-H. Kim 11071, 11072* (SNU). Gimpo-si, Yangchon-myeon, Masan-ri, Seogu, Mt. Gahyeon, 27 Jun 2010, *J.-H. Kim & I.-S. Yoon s. n.* (KB); 3 Aug 2014, *G. S. Bhandari 8031–8032* (SNU). Chungbuk: Jincheon, Mujaebong, 13 Jul 1988, *W. T. Lee s. n.* (KNU); Jincheon-gun, Chopyeong-myeon, Mt. Dootha, 26 Jul 2005, *G. E. Yoo s. n.* (KNU [2 sheets]); Cheongju-si, Sangtang-gu, Wolwudong, Mt. Seondo, 3 Aug 2009, *G. S. Bhandari 1051–1053* (SNU). Chungnam: Taean, Manripo, 13 Aug 1981, *Chung s.n.* (SNU); 11 Aug 2009, *G. S. Bhandari 1101–1111* (SNU)*;* Manripo, 13 Aug 1981, *Chung s.n.* (SNU); Hongseong-gun, Mt. Oseo, 31 May 1997, *S. K. Lee 20* (SNU); 10 Jul 2009, *G. S. Bhandari 801–816* (SNU); 3 Jul 2015, *G. S. Bhandari 1573-1–1573-13-4* (SNU). Seosan, Mt. Buchhun, 14 Jul 2015, *G. S. Bhandari 15714-1–15714-9*

(SNU); 16 Jul 2016, *H. J. Suh & G. S. Bhandari 1679-1–1679-3, 1679-7, 1679-8, 1679-11–1679-13* (SNU). Gwangju: Dong-gu, Jisan-dong, Mt. Mudeong, 5 Aug 2014, *G. S. Bhandari 8051–8058* (SNU). Daegu: Salseong-gun, Mt. Biseul, 6 Jul 2000, *M. H. Kim 580–600* (SNU); 26 Jul 2009, *G. S. Bhandari 1001–1017* (SNU); 28 Sep 2014, *J. H. Park 1* (SNU). Gyeongbuk: Chilgok-gun; Gyeongnam, Milyang-si, Mt. Jongnam, south facing slope, 7 Jun 2008, *Won 622, 625*; 27 Jun 2009, *G. S. Bhandari 630–636* (SNU); Chilgok-gun, Gasanmyeon, Gasan-ri, Gasansanseong, 22 Jul 2014, *G. S. Bhandari 7771–7777* (SNU), *Won 342* (SNU). Gyeongnam: Wiryeong-gun, Garaemyeon, Mt. Jagul, 23 Jul 2014, *G. S. Bhandari 7751–7763* (SNU); 6 Aug 2000, *T. K. Hwan s. n.* (KB); 28 Jul 2002, *J. H. Kim & S. H. Park s. n.* (KB); Mt. Mitha, 9 Jul 2012, *G. S. Bhandari 120709-14–120709-21* (SNU); 29 May 2007, *C. S. Lee et al. A1* (KB); Changwon-si, Wichang-gu, between Mt. Bulmo and Mt. Woong, 6 Jun 2008, *Won 579, 580* (SNU); 14 Aug 2010, *J. H. Park & G. S. Bhandari 5581–5592* (SNU); 8 Aug 1977, *W. T. Lee s. n.* (KNU [2 sheets]); Geoje-si, Mt. Noja, 23 May 2008, *G. S. Bhandari 601* (SNU); on the way between Mt. Noja and Mt. Gara, 24 May 2008, *G. S. Bhandari 602–606* (SNU). Jeonbuk: Jangsu-gun, Gyenam-myeon, Mt. Jangan, 19 Jun 2009, *J. K. Ahn et. al.* (KB); Muju-gun, Jeoksang-myeon, Bukchang-ri, Mt. Jeoksang, 29 Jul 2009, *H. J. Kim s. n.* (KB). Jeonnam: Yeosu-si Dolsan-do, Bongnim–Mt.Bonghwang–Yullimchi, 5 Aug 2003, *S. G. Kwon & W. H. Kim s. n.* (KB); Damyang-gun, Mt. Byeongfung, 11 Jul 2014, *G. S. Bhandari 7721–7723, 7731–7732, 7741, 7742, 7745–7748* (SNU); Wando, Mt. Sammun, 16 Jul 2014, *G. S. Bhandari 7015–7017* (SNU); Haenam-gun, Mt. Duryun, 15 Jul 2014, *G. S. Bhandari 7020–7024, 7026–7035* (SNU).

RUSSIA. Primorsky territory: Khankisky District, vicinities of Komissarovo sattlement, on the mix meadow, Loc 2, 3 Jul 2015, *C. W. Park et al. 57–73, 75–76, 79–95, 97–104, 112–118* (SNU).

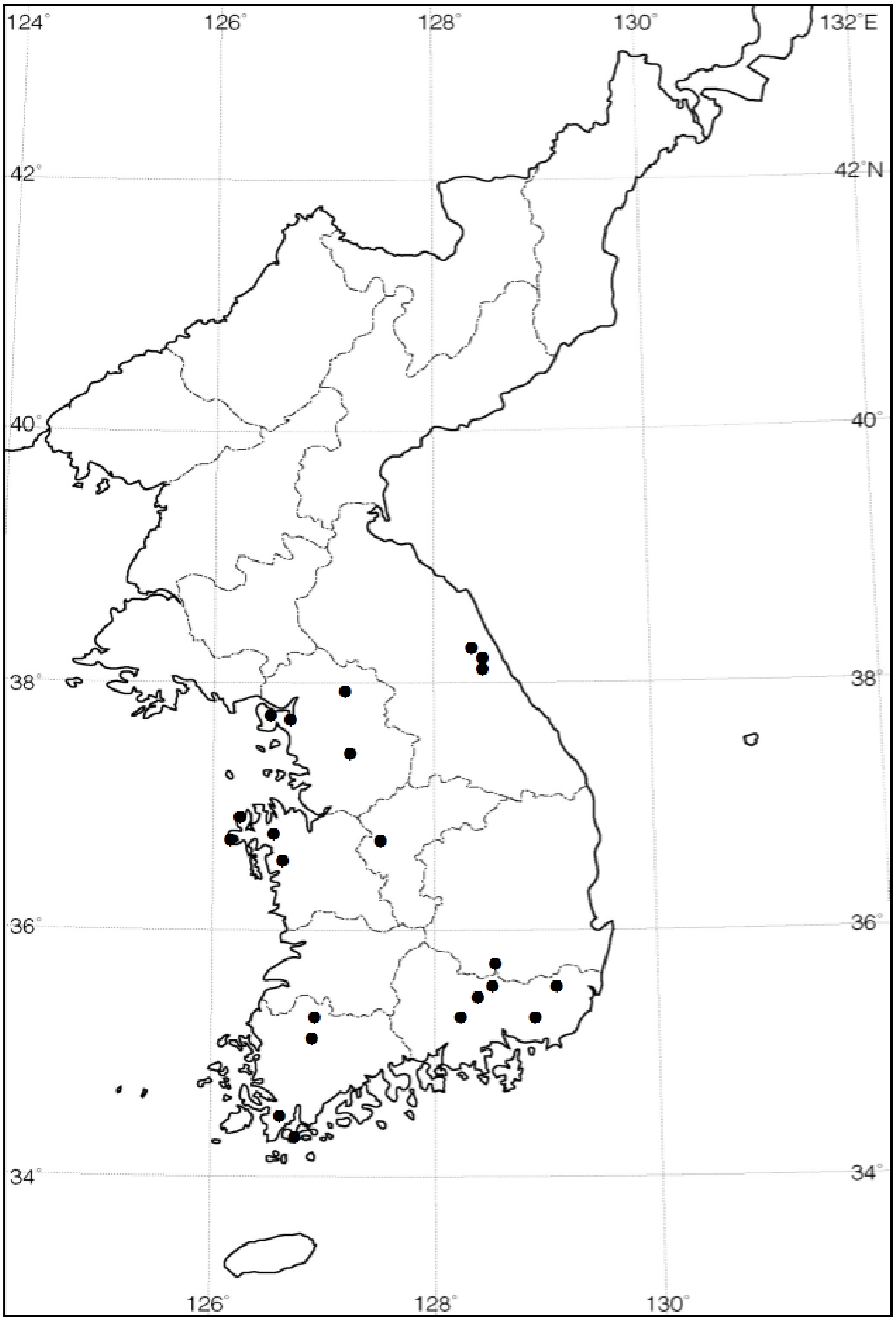

Fig. 19. Distribution of *B. officinalis* subsp. *japonica* in Korea

Fig. 20. Type specimen of *B. major* var. *japonica* (Nakai) H. Hara.

2b. subsp. *angustifolia* (Hayne) C. W. Park comb. nov.

Polygonum bistorta var. *angustifolium* Hayne, Getreue Darstell. Gew. 5: 19, 1817, not Meisn. (1856). *Bistorta vulgaris* Hill var. *angustifolia* (Hayne) H. Gross, Bull. Géogr. Bot. 23: 17, 1913. – Type: not cited.

Korean name: Ga-Neun-Beum-kko-ri (가는범꼬리)

Herbs 20–78 cm tall. Rhizome 0.5–1.2 cm in diam. Stems 3–10, erect, 1–2 mm in diam., herbaceous. Leaves: basal leaves membranous or slightly coriaceous, lanceolate, upper surface green and lower surface grayish green, 8.4–21.8 x 0.6–3.6 cm, bases cuneate, decurrent along petiole, revolute with thickened veins at margin, petiole 3–26 cm long, narrowly winged; lower cauline leaves petiolate, blade lanceolate, base cuneate; middle and upper cauline leaves subsessile, not amplexicaul, cuneate or truncate at base, uppermost cauline leaves linear, ocreae 2–7 cm long. Inflorescences terminal, straight or curved, lax or densely flowered, 1.7–7.1 cm long, ca. 0.6 cm in diam.; monochasia 2–3-flowered; bracts ovate to lanceolate, ca. 3.5–4.5 mm long, awnless or with short awn at apex; pedicels ca. 4 mm long, longer than bracts. Flowers white to pinkish white; tepals narrowly elliptic, sometimes broadly ovate, 1.8–3.2 mm long, acute to obtuse at apex; stamens exserted; filaments 1–3.5 mm long, slender; style 1–3 mm long. Achenes orbicular, sharply trigonous, 2.8–3 x 1.7–2.2 mm, slightly exserted, brown, shiny. Chromosome number: $2n = 24$.

Flowering Jul to Sep.

Distribution: Korea (Mt. Halla).

Bistorta alopecuroides was first reported in Korea (Mt. Halla) by Nakai (1938), who was followed by subsequent Korean taxonomists (Park, 1974; Lee, 1980; Lee, 1996; Park and Hong, 2007). Lee (1996), however, reported *Bistorta major* var. *angustifolia* from Mt. Halla, and Yonekura (2006) identified these individuals as *Bistorta officinalis* subsp. *japonica*. Based on field collections of *B. alopecuroides* from Mongolia and Mt. Halla of Jejudo, and comparison with the type specimens deposited at LE, the individuals of Mt. Halla were found to differ remarkably from *B. alopecuroides* in several characteristics such as plant height, stem diameter, shape and size of basal and cauline leaves and inflorescence length. Moreover, the chromosome counts showed that the individuals of Mt. Halla were diploids ($2n = 24$), in contrast to tetraploid ($2n = 48$) individuals of *B. alopecuroides*. Based on these results, the individuals of Mt. Halla are identified as *B. officinalis* subsp. *angustifolia* in this study.

Additional specimens examined. KOREA. Jejudo: Mt. Halla, 16 jul 1991, *W. G. Baek et al. s. n.* (KNU [2 sheets]); Yeongsil course, 15 Jul 2010, *H. Won & G. S. Bhandari 3051–3069* (SNU); Yeongsil course, 26 Jul 2007, *G. S. Bhandari 308, 310–315* (SNU); 9 May 2008, *G. S. Bhandari 3365, 3372* (SNU); near Witseoreum shelter, 15 Jul 2010, *G. S. Bhandari 3070–3074* (SNU); Mt. Halla, Witseoreum shelter, 15 Jul 2010, *G. S. Bhandari 3075–3076* (SNU); 4 Sep 2014, *C.-S. Kim*

0904-1–0904-7 (SNU); Witseoreum-Oerimok, 15 Jul 2010, *G. S. Bhandari & K.-H. Kim 3077–3080* (SNU); Gwaneumsa course, 16 Jul 2010, *G. S. Bhandari & K.-H. Kim 3101–3114* (SNU); Gwaneumsa course, 16 Jul 2010, *G. S. Bhandari 3114* (SNU); 26 Jul 2007, *G. S. Bhandari 330, 341, 3300* (SNU); 1 Aug 2008, *G. S. Bhandari & Y. Gao 3001–3007*; Baekrokdam, 26 Jul 2007, *H. Won & G. S. Bhandari B1–B7* (SNU); Seongfanak course, 1 Aug 2008, *G. S. Bhandari & Y. Gao 3011–3017* (SNU); Gwaneumsa-Yongingak shelter, 8 Jul 2008, *B. Y. Lee & S. G. Kwon s. n.* (KB).

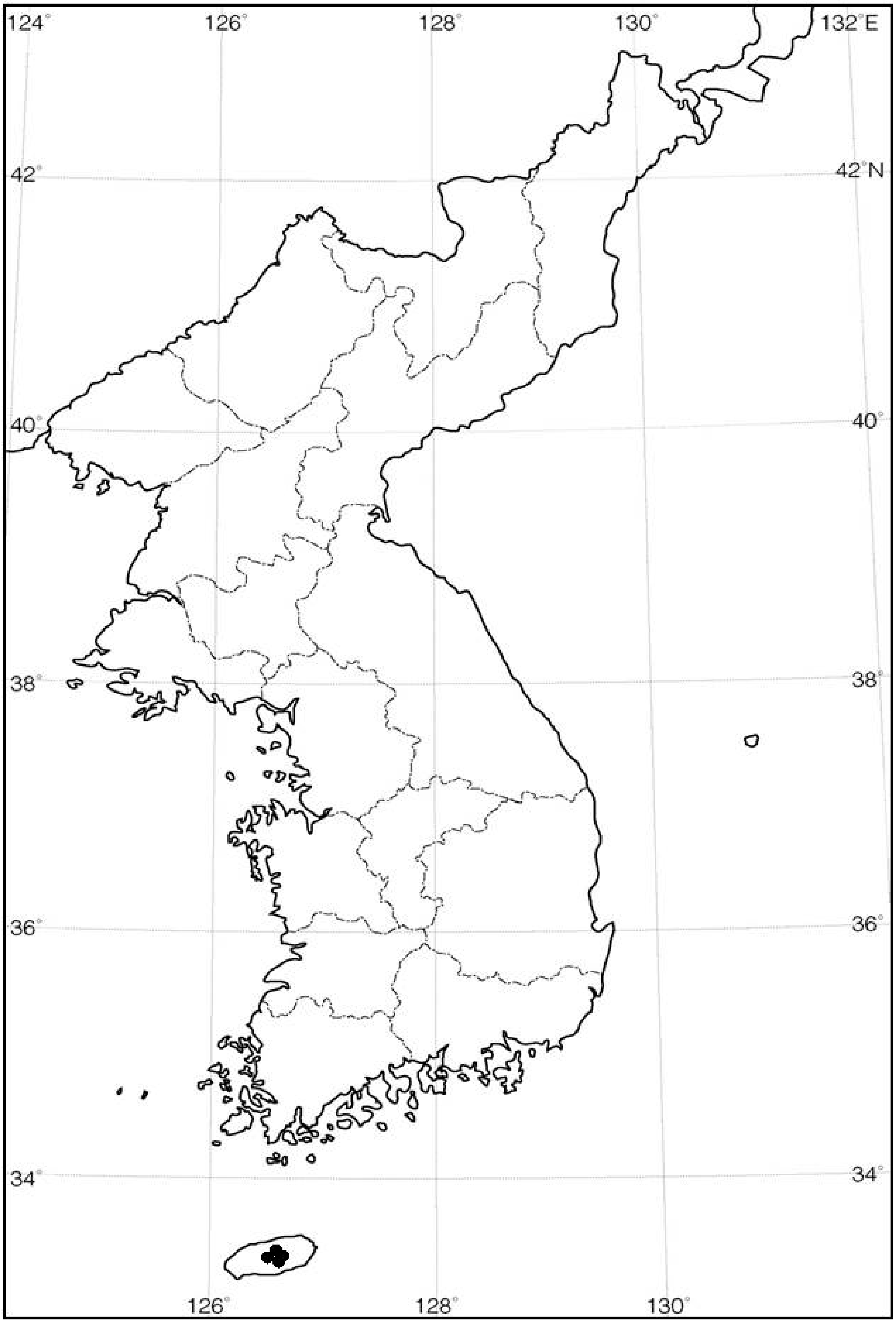

Fig. 21. Distribution of *B. officinalis* subsp. *angustifolia* in Korea.

3. ***Bistorta pacifica*** (Petrov ex Kom.) Kom. ex Nakai, J. Jap. Bot. 14: 1938.

Polygonum pacificum Petrov ex Kom., Bot. Mater. Gerb. Glavn. Bot. Sada S.S.S.R. 6: 2, 1926. *Bistorta vulgaris* Hill var. *pacifica* (Petrov ex Kom.) Miyabe in Miyabe & Kudo, J. Fac. Agric. Hokkaido Imp. Univ. 26: 508, 1934. *Bistorta major* Gray var. *pacifica* (Petrov ex Kom.) H. Hara, J. Jap. Bot. 13: 382, 1937. *Polygonum bistorta* L. subsp. *pacificum* (Petrov ex Kom.) Vorosch., in A. K. Skvortsov, Florist. Issl. v Razn. Raionakh SSSR 163, 1985. *Bistorta officinalis* Delarbre subsp. *pacifica* (Petrov ex Kom.) Yonek., Fl. Jap. (Iwatsuki et al., eds.) 2a: 144, 2006. Type: Russia. Far East: "sinus America, pagum Americanka, in valle supra lacum putridum, pratincolae silvaticae ad ripas rivuli, sparse, deflorens", 29 Aug 1913, *Komarov 1204* (lectotype: LE [not seen]); "insula Putjatin, in fruticetis ad cacumen montis, ad florendi initium", 19 Jun 1913, *A. Bulavkina 200* (syntype: LE [not seen]); "in valle fl. Suifun, in vicinitate pag. Rasdolnoje, in declilivio herboso, in pleno anthesi", 30 Jun 1913, *N. V. Schipczinskij 280* (syntype: LE [not seen]).

Bistorta vulgaris Hill var. *ovata* Nakai ex H. Hara, Bot. Mag. (Tokyo) 48: 890, 1934. *Bistorta major* Gray var. *ovata* (Nakai ex H. Hara) H. Hara, J. Jap. Bot. 13: 382, 1937. *Bistorta vulgaris* Hill var. *nitens* (Fisch. & C. A. Mey.) Nakai, Miyabe & Kudo, J. Fac. Agric. Hokkaido Imp. Univ. 26(4): 508, 1934, not Nakai (1926). Type: Japan. Yezo: prov. Ishikari, Mt. Yubari, Aug 1916, *G.*

Koidzumi s. n. (holotype: TI [not seen]); Mt. Daisetsu, Aug 1928, *T. Nakai s.n.* (paratype: TI [not seen]).

Polygonum bistorta var. *ussuriense* Regel, 1861; *P. ussuriense* (Regel) Petrov ex Kom., 1926. *Bistorta ussuriensis* (Regel) Kom., 1926 (pro syn.). Type: Russia. “Ussuri dec. med. Promontorium Chat, fl.”, 1859, *R. Maak s. n.* (lectotype: LE [not seen]); “id. Ostium affluentis Tschirku, fl.”, without specific date, *R. Maak s. n.* (syntype: LE [not seen]).

Korean name: Cham-beom-kko-ri (참범꼬리)

Herbs 40–110 cm tall. Rhizomes 1.5–3 cm in diam., blackish brown. Stems 2–4, erect. Leaves basal and cauline, membranous to coriaceous; basal leaf blade narrowly to widely ovate, undulate, 5–17.8 x 3–9.6 cm, acute at apex, bases subcordate or cordate, decurrent along petiole, forming narrow or sometimes wide wings, upper surface green, lower surface grayish green, glabrous or lower surface sparsely or densely pubescent with white hairs, usually prominent leaf veins on the lower leaf surface, margin slightly revolute, basal leaves long petiolate; petiole 8–38 cm long; lower cauline leaves ovate or lanceolate-ovate, bases cordate, petiolate, middle and upper cauline leaves ovate to lanceolate, sessile, amplexicaul, uppermost cauline leaf narrowly lanceolate to filiform; ocrea 3–7 cm long, membranous, glabrous or hairy, lacerate at upper part. Inflorescences terminal, compact, 3–5.7 cm long, 1.2–1.5 cm in diam.; monochasia 1–3-flowered, closely spaced; bracts broadly elliptic to ovate, 3–4 mm long, caudate at apex; pedicels 4–5 mm long, longer than bracts, slender. Flowers white or pinkish, perianth ca. 2.5–3.2 mm long; tepals elliptic to oblong, obtuse at apex; stamens exserted; filaments 2–5 mm long, 1.5–3 mm long. Achenes sharply trigonous, ovate in outline, ca. 3.3–4 x 2–2.7 mm, slightly exserted, black-brown, shiny. Chromosome number $2n = 48$.

Flowering Jun to Aug.

Distribution: NE China, Korea, Russian Far East.

Korea: North Korea, Gangwon, Gyeongnam.

Bistorta pacifica was first reported in Korea by Nakai (1938). He was followed by subsequent Korean authors (Park, 1974; Lee, 1980; Lee, 1996; Lee, 1996; Park & Hong, 2007). One closely related taxon, *Bistorta major* var. *ovata* Nakai ex H. Hara, was reported from Japan by Nakai (1926). This taxon is similar to *B. pacifica* in having thick tortuous rhizome, ovate basal leaf with cordate base and prominent leaf veins on abaxial surface. Chromosome counts in the present study revealed that both taxa have identical chromosome numbers ($2n = 48$). Moreover, phylogenetic analyses based on cpDNA sequence data showed that the individuals of *B. major* var. *ovata* collected from type locality from Japan formed a clade with the individuals of *B. pacifica* from Russia (locus classicus). Based on these results, *B. major* var. *ovata* is transferred to *B. pacifca* in this study.

Additional specimens examined: CHINA. Jilin: Tumen-si, Janganjin (Chang'anzhen), Mt. Yasan, 23 Jul 2014, *T. Y. Choi 3–13* (SNU).

JAPAN. Hokkaido: Yezo, Rishiri, 06 Jul 1914, *Tamaki s. n.* (TI 2690); 11 Aug 1921, *Col?* (TI 2696); 06 Sep 1926, *Kando s. n.* (TI 7610); Sohya, Mt. Rishiri in Rishiri Isl., 15 Aug 1984, *T. Kato & S. Sakai 4197* (TI); Mt. Rishiri, 6 Jul 1914, *col.?* (TI) Yezo, Rebun-do, 10 Jul 1914, *Tamaki s.n.* (TI); Mt. Yubari, 08 Aug 1913, *S. Tamaki s. n.* (TI); Mt. Yubari, Kanayamaguchi, 21 Jul 1933, *H. Hara s. n.* (TI); Sapporo, Aug 1928, *T. Nakai 2748, 2749* (TI); Mt. Obira, Shimamaki, Shimamaki District, Hokkaido, 25 Jul 2014, *H.-M. Kim 28–32* (SNU); Rebun Island, 21 Jun 2016, *H.-J. Suh 1–5* (SNU); near Momoiwa in Rebun Island, 1952, *M. Hiroe 7602* (TI); Rebun Isl., 10 Jul 1914, *Col.?* (TI); Oshima-shicho, Matsumae-gun, Fukushima-cho, Mt. Daisengendake, 24 Jul 1977, *K. Takeda s. n.* (TI [2 sheets]); Shiribeshi, Shiribeshi-gun, Shimamaki-mura, Mt. Ohira-yama, 5 Aug, 1983, *H. Takahashi et al. 79* (TI). Honshu: Niigata, Mts. Iide, in between Mt. Eburisashidake & Mt. Ohishi-yama, 10 Aug 1982, *Y. Tateishi et al. 8889* (TI); Iwate, Ushigata-yama, 20 Jul 1962, *M. Takahashi s. n.* (TI)

KOREA. Hamnam: Hamjiwon, 16 Jul 1934, *Toh & Shim s. n.* (SNU 1458, 1459); Bujeon Plateau, 20 Jul 1938, *Toh & Shim s. n.* (SNU 1457); Pyeong-buk: Mt. Myohyang, 20 Jul 1938, *Toh & Shim s. n.* (SNU); Yanggang: Mt. Baekdu, Aug 1990, *Yoon s. n.* (SNU). Hwanghaenam: Jangsangot, 4 Aug 1930, *Nakai s. n.* (SNU 1450). Gyeonggi-do: Gapyeong-gun, Buk-myeon, Mt. Hwa-ak, 26 Jun 2008, *G. S. Bhandari 201–208* (SNU). Gangwon-do: Inje-gun, Wolhak-ri, Mt. Daeam, 7 Jul 1995, *W. T. Lee s. n.* (KNU [2 sheets]); 26 Jul 1988, *W. T. Lee s. n.* (KNU); 28 Jul 1988, *W. T. Lee s .n.* (KNU); Youngneof, 22 Jun 2000, *K. C. Yang & J. D. Jung s. n.*

(KB); 4 Jul 1967, *Jeong & An s. n.* (SNU); 13 Jul 1967, *Chung s.n.* (SNU [5 sheets]); 5 Oct 1972, *Jeong & An s. n.* (SNU); 23 Aug 2014, *H. J. Suh & G. S. Bhandari 823-1–823-12* (SNU); 4 Aug 2015, *H. J. Suh 1584-1–1584-7* (SNU); 26 Jun 2016, *H. J. Suh & G. S. Bhandari 16626-01–16626-07, 16626-15–16626-22* (SNU); Inje-gun, Sangnam-myeon, Misan-ri, Mt. Bangtae, 18 Jul 2007, *Y. D. Kim & S. H. Cho s. n.* (KB); Mt. Myeon, 10 Jun 1990, *S. H. Oh s. n.* (SNU); Pyeongchang-gun, Mt. Cheongok, 26 Jun 2000, *W. T. Lee s. n.* (KNU [2 sheets]); *H. J. Suh & G. S. Bhandari 16630-22–16630-26, 16630-31* (SNU); *G. S. Bhandari 1401–1417* (SNU); 14 Jun 2008, *S.-J. Lee 650* (SNU); Pyeongchang-gun, Hwaryeongbong, 21 Jun 1998, *W. T. Lee s. n.* (KNU); Bongpyeong-myeon, Mui-ri, Mt. Taegi, 27 Jul 1976, *W. T. Lee s. n.* (KNU); 17 Jun 1990, *W. T. Lee s. n.* (KNU); 8 Aug 2009, *S. C. Ko & D. C. Son s. n.* (KB); 25 Jun 2010; Hongseong-gun, Dunnaemyeon, Mt. Taegi; *H. J. Suh & G. S. Bhandari 16630-27–30* (SNU); Samcheok, Mt. Daeseong, 25 May 1983, *W. T. Lee s. n.* (KNU); Samcheok-si, Singi-myeon, Daeri-ri, Mt. Deokhang, 7 Jul 2006, *C. S. Lee et al. LEECS070693* (KB) ; Jeongseon-gun, Mt. Gariwang, 16 Jun 1996, *W. T. Lee s. n.* (KNU); 25 Jun 2009, *G. S. Bhandari 151–157, 159–169, 171–173* (SNU)*;* Taebaek-si, Geumdaebong, 30 Jun 2009, *C. S. Lee et al. 090570* (KB); Taebaek-si, Mt. Daetak, 13 Aug 2004, *G. E. Yoo s. n.* (KNU [2 sheets]); Mt. Hambaek Pop1, 30 Jul 2014, *G. S. Bhandari 7075, 7077–7080* (SNU); Pop2, 30 Jul 2014, *G. S. Bhandari 7081–7091* (SNU); Jeongseon-gun, Gohan-eup, Gohan-ri, Mt. Hambaek, 8 Jul 2009, *S. C. Ko & D. C. Son HNHM-1916, HNHM-1919.* (KB); Gohan-ri, Geumdae-bong *G. S. Bhandari 1225* (SNU); 30 Jul 2014, *G. S. Bhandari 7092, 7093* (SNU); Taebaek-si, Mt. Taebaek, 15 Jul 1996, *J. Song 00137* (SNU); 15 Jul 2008, *G. S. Bhandari*

701–705 (SNU)*;* 23 Jul 1986, *W. T. Lee s. n.* (KNU); Hongcheon-gun, Naemyeon, Mt. Gyebang, 24 Jul 2012, *G. S. Bhandari 2012724-1–12* (SNU); 16 Jun 1993, *G. E. Yoo & W. T. Lee s. n.* (KNU [2 sheets]); Hongcheon-gun, Jaun-ri, 1150, 1 Jul 2015, *H. J. Suh 1571-1* (SNU); Jeongseon-gun, Gohan-ri 216-1, Manhangje, *H. J. Suh & G. S. Bhandari 16630-34–16630-39* (SNU); 5 Jul 2015, *H. J. Suh 1575-1–1575-7* (SNU); *H. J. Suh & G. S. Bhandari 16630-1–6, 16630-32, 16630-33, 16630-40* (SNU); Wonju-si, Mt. Chiak, 22 Jul 2006, *G. E. Yoo s. n.* (KNU). Chungbuk: Yeongdong-gun, Mt. Minjuji, 11 Aug 1976, W. T. Lee (KNU); 10 Jul 2010, *G. S. Bhandari 1501–1512, 1515* (SNU); 24 Aug 2014, *J. H. Park 1* (SNU). Gyeongbuk: Yeongjusi, Punggi-ub, Sucheol-ri, Sobaeksan, abt. 50 m below the peak (1383 m); near Astronomical Observatory, 7 Jul 2007, *G. S. Bhandari 2, 4, 9, 15, 51–53, 55–59* (SNU); Yeongjusi, Punggi-ub, Sucheol-ri, Mt. Sobaek, Yeonghwa-bong, 7 Jul 2007, *G. S. Bhandari 6, 40* (SNU); Yeongyang-gun, Ilwol-myeon, Mt. Ilwol, 29 Jul 11, *G. S. Bhandari 11726-1–3, 11726-7–9* (SNU); Bonghwa-gun, Seokpo-myeon, Seokpo-ri, Duribong, 5 Jul 2008, *G. Y. Chung ANH-en-080705-044* (KB); 5 Jul 2008, *G. Y. Chung & M.-S. Park s. n.* (KB). Gyeongnam: Sancheong-gun, Jungsan-ri, Mt. Jiri, Jangthmok shelter, 6 Aug 2007, *G. S. Bhandari 501–503, 505, 507, 509–510, 512–518* (SNU); 6 Aug 2007, *G. S. Bhandari 521* (SNU); Saeseok shelter, 6 Aug 2007, *G. S. Bhandari 532, 535, 536* (SNU); Sancheong-gun, Sicheon-myeon, Sa-ri, Mt. Jiri, Banyabong, 3 Jun 2002, *C. H. Kim et al. s. n.* (KB); Wangdeong wetland, 1 Jul 2010, *G. S. Bhandari 551, 551-1, 552, 553-1, 553-2, 554-1, 554-2* (SNU); near Hyeongje-bong, 21 Jul 2000, *M.-H. Kim 664–668* (SNU); Mt. Jiri, 17 Aug 1978, *W. T. Lee s. n.* (KNU). Jeonbuk: Muju-gun, Mt. Deokyu, 15 Jul 2011, *G. S. Bhandari 11101–11108* (SNU). Jeonnam:

Mt. Jiri, Dwajipyeongjeon, 20 Jul 2000, *M. H. Kim 650–653* (SNU); Mt. Jir, near Tokki-bong, 20 Jul 2000, *M. H. Kim 655–663* (SNU).

RUSSIA. Primorsky territory: Shkotovsky District, vicinities of Nahodka city, near Griloye Lake, 1 Jul 2015, *C. W. Park et al. 10–14, 16–19* (SNU); west border of Ussuriysky Preserve, 17 Jul 2014, *C. W. Park & T. Y. Choi 107, 108* (SNU); Sakhalin: Isl. Kaiba, 18 Jul 1929, *S. Saito s. n.* (TI).

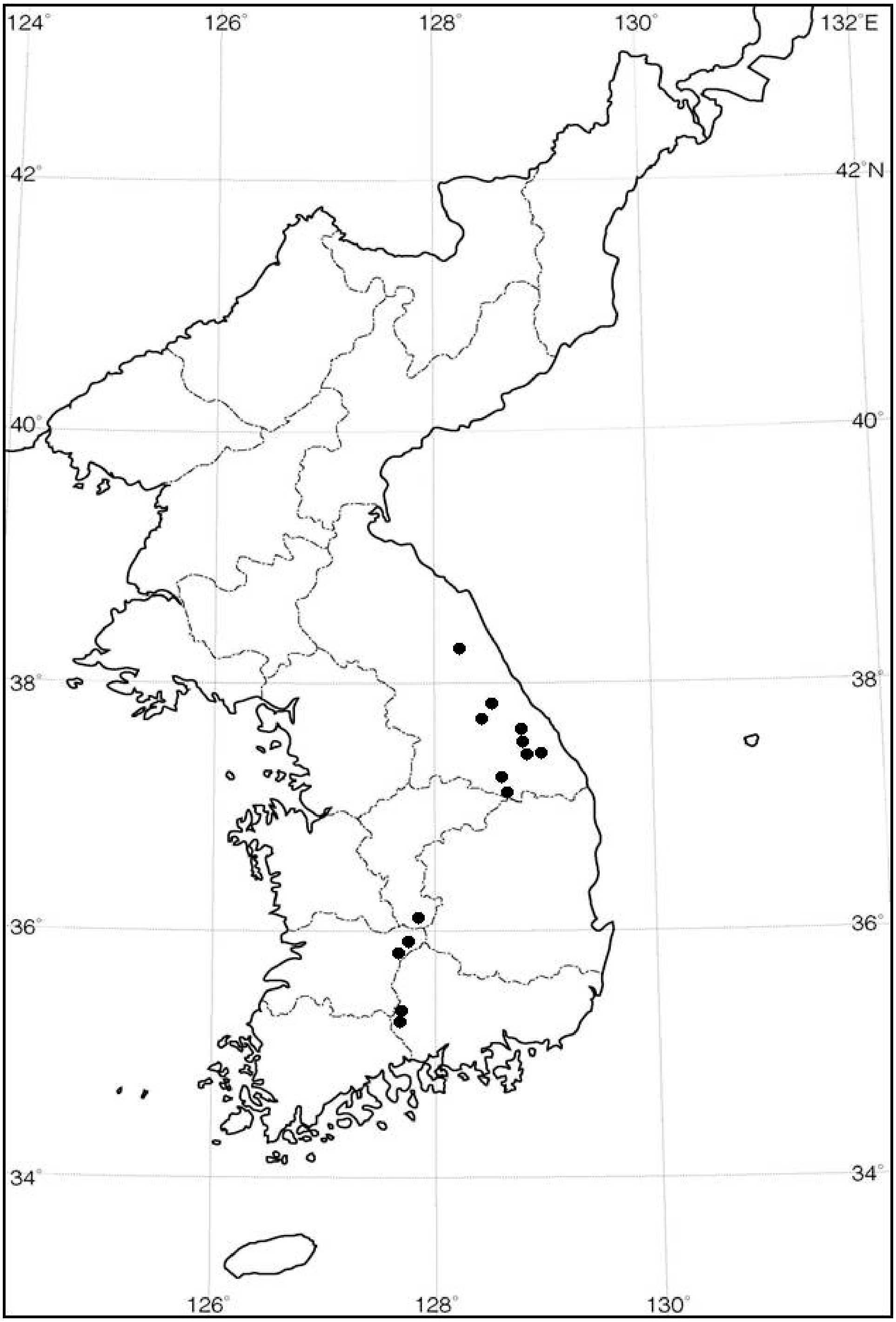

Fig. 22. Distribution of *B. pacifica* in Korea.

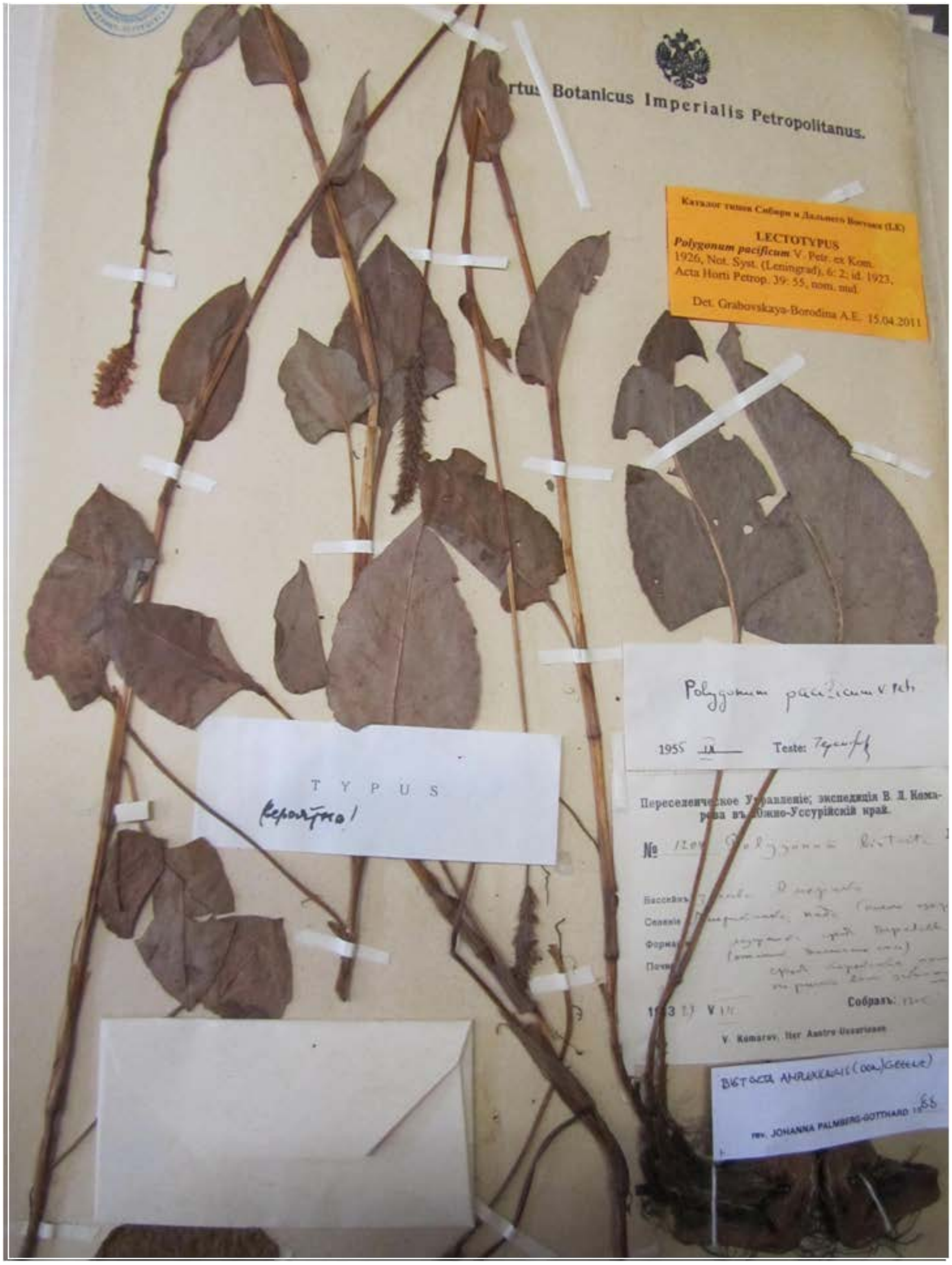

Fig. 23. Lectotype of *B. pacifica* (Petrov ex Kom.) Kom. ex Nakai

Fig. 24. Holotype of *B. major* var. *ovata* (Nakai ex H. Hara) H. Hara.

4. ***Bistorta koreana*** C. W. Park & G. S. Bhandari sp. nov.

Type: Korea. Gangwon-do, Inje-gun, Buk-myeon, Mt. Seorak, Daecheongbong, N38°07’ 08.88” E128° 27’ 54.98”, 1693 m, 21 Jun 2016, *G. S. Bhandari 16621-1* (holotype, SNU).

Korean name: Seol-ak-beom-kko-ri (설악범꼬리)

Herbs 49.5–71 cm tall. Rhizomes 0.6–1.1 cm in diam., tortuous, light brown. Stems 2–7, erect, ca. 4 mm thick, pale green. Leaves basal and cauline, coriaceous, both surfaces glabrous; upper surface dark green, lower surface pale green, basal leaves petiolate, leaf blade narrowly ovate to lanceolate-elliptic, 9–19.3 x 3.8–8.6 cm, acuminate at apex, bases cordate to subcordate, decurrent along petiole forming narrow wings or wings nearly absent, margin weakly reovolute, undulate; petiole 16.4–50.6 cm, narrowly winged at the junction with the leaf blade; cauline leaves lanceolate, lower 1–2 cauline leaves petiolate, middle and upper ones sessile, base cordate, amplexicaul, auriculate base, middle leaves usually strongly undulate and curved, upper penultimate leaf linear, uppermost leaf linear or filiform; ocrea 3.2–10.8 cm long, membranous, eciliate or sometimes ciliate. Inflorescences terminal, rarely terminal and axillary, compact, 2–7 cm long, ca. 1.5 cm in diam.; monochasia 2- to 3-flowered, closely spaced; bracts obovate to lanceolate, ca. 3 mm long, membranous, cuspidate at apex. Flowers pinkish or white; tepals elliptic to oblong, ca. 3 mm long, obtuse at apex; stamens exserted;

filaments 3.5–4 mm long, anthers dark purple; style 3-cleft at base, exserted. Achenes ellipsoid in outline, 3.2–4 x 1.8–2.1 mm wide, enclosed, dark brown, shiny. Chromosome number 2*n* = 24.

Flowering May to Jun.

Distribution: *B. koreana* is only found on Mt. Seorak of Korea, where it grows in open area on top of the mountain.

Etymology: The species epithet denotes the fact that the species is so far known only known from Korea.

This taxon resembles to *Bistorta pacifica* in having cordate leaf base, weakly winged petiole and thick inflorescence (Komarov, 1936; Nakai, 1938). *Bistorta koreana*, however, differs from *B. pacifica* in having shorter stature, relatively narrow lamina of basal leaves, curved middle leaf with undulate margin and presence of second linear cauline leaf from the top. DNA sequence data revealed that these plants do not contain the general ribotype R1 that was found in nearly all individuals of all taxa of the *B. manshuriensis* complex suggesting their different evolutionary history. Moreover, the individuals of *B. koreana* is diploid (2*n* = 24) compared to tetraploid (2*n* = 48) *B. pacifica*. Based on morphological, chromosomal and molecular data, a new species, endemic to Korea, is proposed in this study.

Additional specimens examined: KOREA. Gangwon-do, Inje-gun, Mt. Seorak, 26 Jul 1996, *W. T. Lee s. n.* (KNU); 16 Jun 1977, *B. G. Yoon s. n.* (KNU); 17 Jun 1977, *B. G. Yoon s. n.* (KNU); 11 Jul 1977, *B. G. Yoon s. n.* (KNU); 12 Aug 2001, *M. H. Kim 735, 742, 745* (SNU); 20 Jul 2007, *H. Won & G. S. Bhandari 401–405* (SNU); 28 Aug 2013, *T. Y. Choi 1* (SNU); 16 Jun 2016, *G. S. Bhandari 16621-1–9, 11–17* (SNU).

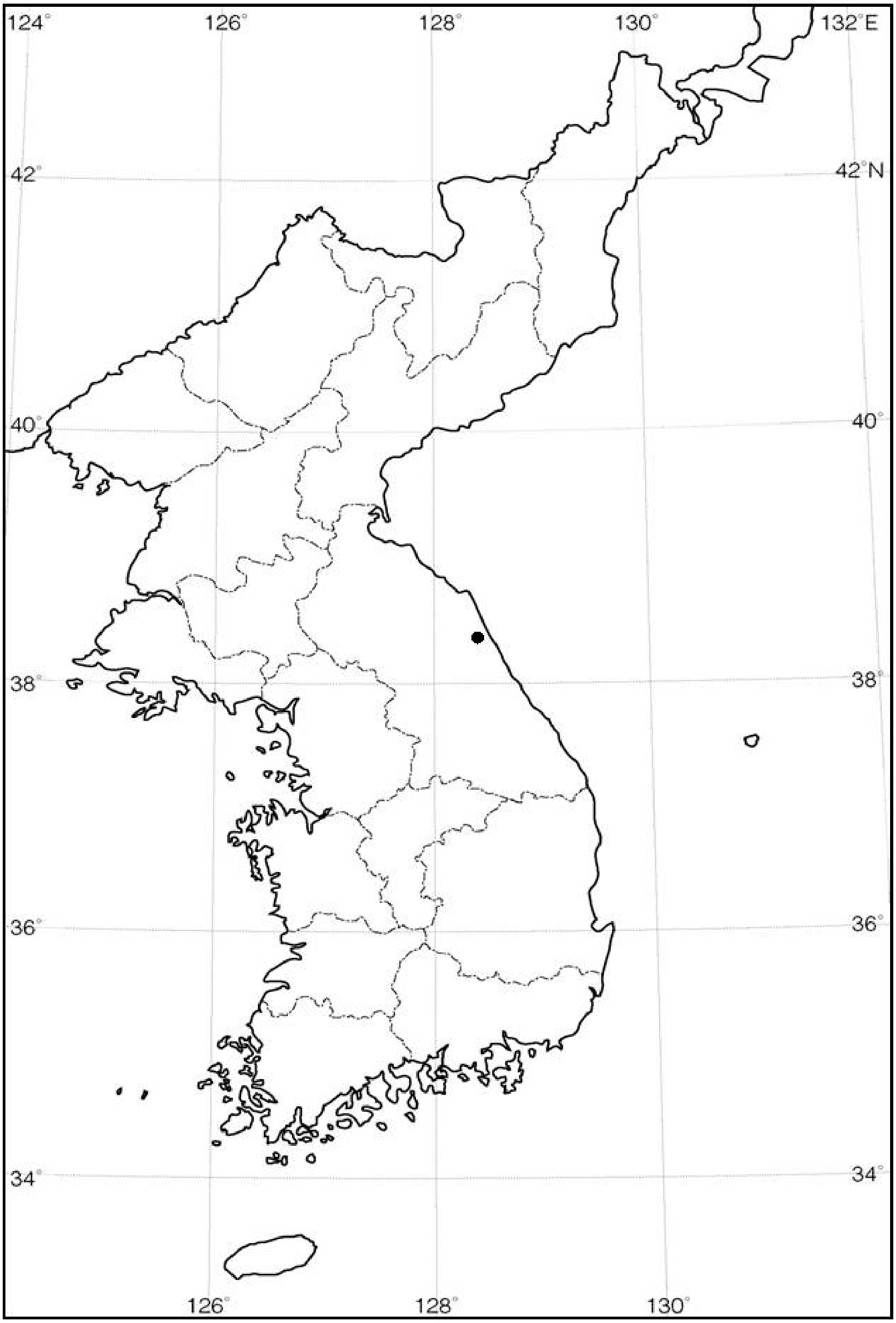

Fig. 25. Distribution of *B. koreana*

Fig. 26. Holotype of *Bistorta koreana* C. W. Park & G. S. Bhandari

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Appendix 1.

Aligned sequences of nrDNA ITS region from taxa of the *B. manshuriensis* complex and related taxa. See Table 4 for acronyms. Dashes (-) indicate gaps and dots (.) indicate matched sequences to the first taxon.

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                                                                                                                  110
A1_kr_gr1 c1       TCGAAACCTGCACAAGCAGAAAGACCCGCGAACTCGTTTACAAACACCCGAGGGGCAGGGCTCGGCCAAAACCGGCGCTGCCCCTCACACCAACGAACCCCGGCGCGGAT
A1_kr_gr1 c2       ..............................................................................................................
A2_kr_hl3 c1       ..............................................................................................................
A2_kr_hl3 c2       ..............................................................................................................
A2_kr_hl5 c1       ..............................................................................................................
A2_kr_hl5 c2       ..............................................................T...............................................
A3_kr_hl5 c1       ..............................................................................................................
A3_kr_hl5 c2       ..............................................................................................................
A4_kr_hl9 c1       ..............................................................................................................
A4_kr_hl9 c2       ..............................................................................................................
A5_kr_hl10 c2      ...............................................................A..............................................
A5_kr_hl10 c1      ..............................................................T...............................................
A5_kr_hl10 c3      ..............................................................................................................
A5_kr_hl10 c4      ..............................................................T...............................................
A5_kr_hl10 c5      ..............................................................................................................
A5_kr_hl10 c6      ...............................................................A..............................................
A5_kr_hl11 c1      ..............................................................................................................
A5_kr_hl11 c2      ..............................................................................................................
A7_mn_1            ..............................................................................................................
A8_mn_2 c1         ..............................................................................................................
A8_mn_2 c2         ..............................................................................................................
M2_rs_kh1 c1       ..............................................................................................................
M2_rs_kh1 c2       ..............................................................................................................
M2_rs_kh3 c1       ..............................................................................................................
M2_rs_kh3 c2       ..............................................................................................................
M2_rs_kh3 c3       ..............................................................................................................
M2_rs_kh3 c4       ..............................................................................................................
M3_rs_kh6 c1       ..............................................................................................................
M3_rs_kh6 c2       ..............................................................................................................
M3_rs_kh8 c1       ..............................................................................................................
M3_rs_kh8 c2       ..............................................................................................................
M3_rs_kh20 c1      ..............................................................................................................
M3_rs_kh20 c2      ..............................................................................................................
M3_rs_kh22 c1      ..............................................................................................................
M3_rs_kh23 c1      ..............................................................................................................
M3_rs_kh23 c2      ..............................................................................................................
M3_rs_kh24         ..............................................................................................................
M3_rs_kh25 c1      ..............................................................................................................
M3_rs_kh25 c2      ..............................................................................................................
M3_rs_kh28 c1      ..............................................................................................................
M3_rs_kh28 c2      ..............................................................................................................
M3_rs_kh29         ..............................................................................................................
M3_rs_kh31 c1      ..............................................................................................................
M3_rs_kh31 c2      ..............................................................................................................
M3_rs_kh31 c3      ..............................................................................................................
M3_rs_kh31_1 c1    ..............................................................................................................
M3_rs_kh31_1 c2    ..............................................................................................................
M4_rs_kh32 c1      ..............................................................................................................
M4_rs_kh32 c2      ................................................T.............................................................
M5_rs_ot1          ..............................................................................................................
M6_rs_is2 c1       ..............................................................................................................
M6_rs_is2 c2       ..............................................................................................................
M7_cn_hj0 c1       ..............................................................................................................
M7_cn_hj0 c2       ..............................................................................................................
M8_cn_hj3_1 c1     ..........................................................................A...................................
M8_cn_hj3_1 c2     ..............................................................................................................
M8_cn_hj2          ..............................................................................................................
M8_cn_hj4          ..............................................................................................................
M8_cn_hj5 c1       ..............................................................................................................
M8_cn_hj5 c2       ..............................................................................................................
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Appendix 1. (Continued).

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                                                                                                                         110
A1_kr_gr1 c1        TCGAAACCTGCACAAGCAGAAAGACCCGCGAACTCGTTTACAAACACCCGAGGGGCAGGGCTCGGCCAAAACCGGCGCTGCCCCTCACACCAACGAACCCCGGCGCGGAT
M9_cn_hj5           ..............................................................................................................
M13_kr_od c1        ..............................................................................................................
M13_kr_od c2        ..............................................................................................................
M13_kr_od c3        ..............................................................T...............................................
M14_kr_jm1 c1       ..............................................................................................................
M14_kr_jm1 c2       ..............................................................T...............................................
M16_kr_dr1 c1       ..............................................................................................................
M16_kr_dr1 c2       ..............................................................................................................
M18_kr_hg1 c1       ..............................................................................................................
M18_kr_hg1 c2       ..............................................................................................................
M20_kr_nh1 c1       ..............................................................T...............................................
M20_kr_nh1 c2       ..............................................................................................................
M20_kr_nh1 c3       ..............................................................................................................
M20_kr_nh1 c4       ..............................................................T...............................................
M21_kr_gu1 c1       ..............................................................................................................
M21_kr_gu1 c2       ..............................................................................................................
M21_kr_gu1 c3       ...............................................................A..............................................
M21_kr_gu1 c4       ..............................................................................................................
M22_kr_mp1 c1       ..............................................................................................................
M22_kr_mp1 c2       ..............................................................................................................
M25_kr_os2 c1       ..............................................................................................................
M25_kr_os2 c2       ..............................................................................................................
M25_kr_os3          ..............................................................................................................
M25_kr_os4 c1       ..............................................................................................................
M25_kr_os4 c2       ..............................................................................................................
M28_kr_bs1          ..............................................................................................................
M28_kr_bs2 c1       ..............................................................................................................
M28_kr_bs2 c2       ..............................................................................................................
M28_kr_bs2 c3       ..............................................................T...............................................
M30_kr_bl2 c1       ..............................................................................................................
M30_kr_bl2 c2       ..............................................................T...............................................
M32_kr_mt1 c1       ..............................................................T...............................................
M32_kr_mt1 c2       ..............................................................................................................
M33_kr_md2 c1       ..............................................................................................................
M33_kr_md2 c2       ..............................................................................................................
M34_kr_dn1 c1       ..............................................................................................................
M34_kr_dn1 c2       ..............................................................................................................
M34_kr_dn2 c1       ..............................................................................................................
M34_kr_dn2 c2       ..............................................................T...............................................
M35_kr_sm1 c1       ..............................................................................................................
M35_kr_sm1 c2       ..............................................................T...............................................
M35_kr_sm2 c1       ..............................................................................................................
M35_kr_sm2 c2       ..............................................................................................................
P1_rs_ms1 c1        ..............................................................T...............................................
P1_rs_ms1 c2        ..............................................................................................................
P1_rs_ms3 c1        ..............................................................................................................
P1_rs_ms3 c2        ..............................................................T...............................................
P1_rs_ms3 c3        ..............................................................T...............................................
P1_rs_ms3 c4        ..............................................................T...............................................
P1_rs_ms3 c5        ..............................................................................................................
P2_rs_nk2           ..............................................................................................................
P3_rs_pr1           ..............................................................................................................
P4_rs_pr2 c1        ..............................................................................................................
P4_rs_pr2 c2        ..............................................................................................................
P4_rs_pr2 c3        ......................................................C.......................................................
P4_rs_pr3 c1        ..............................................................................................................
P4_rs_pr3 c2        ......................................................C.......................................................
P5_rs_rc1 c1        ..............................................................................................................
P5_rs_rc1 c2        ..............................................................................................................
P5_rs_rc1 c3        ..............................................................................................................
P5_rs_rc1 c4        ..............................................................................................................
P5_rs_rc1 c5        ..............................................................................................................
P6_rs_rc7           ..............................................................................................................
P7_rs_us1           ..............................................................................................................
P7_rs_us2 c1        ..............................................................................................................
P7_rs_us2 c2        ..............................................................T...............................................
P7_rs_us2 c3        ..............................................................T...............................................
P7_rs_us2 c4        ..............................................................................................................
P7_rs_us2 c5        ..............................................................A...............................................
```

Appendix 1. (Continued).

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                                                                                                                            110
A1_kr_gr1 c1     TCGAAACCTGCACAAGCAGAAAGACCCGCGAACTCGTTTACAAACACCCGAGGGGCAGGGCTCGGCCAAAACCGGCGCTGCCCCTCACACCAACGAACCCCGGCGCGGAT
P9_rs_pr5        ..............................................................................................................
P10_cn_jl1 c1    ..............................................................................................................
P10_cn_jl1 c2    ..............................................................................................................
P11_cn_jl3 c1    ..............................................................................................................
P11_cn_jl3 c2    ..............................................................................................................
P11_cn_jl4 c1    ..............................................................T...............................................
P11_cn_jl4 c2    ..............................................................................................................
P12_cn_sn2 c1    ..............................................................T...............................................
P12_cn_sn2 c2    ..............................................................................................................
P12_cn_sn2 c3    ..............................................................................................................
P12_cn_sn2 c4    ..............................................................................................................
P13_cn_mc1 c1    ..............................................................T...............................................
P13_cn_mc1 c2    ..............................................................................................................
P13_cn_mc1 c3    ..............................................................................................................
P13_cn_mc2 c1    ..............................................................T...............................................
P13_cn_mc2 c2    ..............................................................................................................
P13_cn_mc2 c3    ..............................................................................................................
P13_cn_mc2 c4    ..............................................................................................................
P14_kr_hw1 c1    ..............................................................................................................
P14_kr_hw1 c2    ..............................................................T...............................................
P14_kr_hw1 c3    ..............................................................T...............................................
P15_kr_dm1 c1    ..............................................................T...............................................
P15_kr_dm1 c2    ..............................................................T...............................................
P15_kr_dm1 c3    ..............................................................................................................
P16_kr_sk2 c1    ..............................................................T...............................................
P16_kr_sk2 c2    ..............................................................T...............................................
P16_kr_sk2 c3    ..............................................................................................................
P16_kr_sk5 c1    ..............................................................T...............................................
P16_kr_sk5 c2    ..............................................................T...............................................
P17_kr_sh1 c1    ..............................................................................................................
P17_kr_sh1 c2    ..............................................................T...............................................
P17_kr_sh1 c3    ..............................................................T...............................................
P17_kr_sh1 c4    ..............................................................................................................
P17_kr_sh1 c5    ..............................................................................................................
P17_kr_sh1 c6    ..............................................................................................................
P19_kr_gw1 c1    ..............................................................................................................
P19_kr_gw1 c2    ..............................................................................................................
P19_kr_gw1 c3    ..............................................................T...............................................
P19_kr_gw1 c4    ..............................................................T...............................................
P19_kr_gw3 c1    ..............................................................................................................
P19_kr_gw3 c2    ..............................................................T...............................................
P19_kr_gw3 c3    ..............................................................T...............................................
P20_kr_ck1 c1    ..............................................................T...............................................
P20_kr_ck1 c2    ..............................................................T...............................................
P20_kr_ck1 c3    ..............................................................T...............................................
P20_kr_ck1 c4    ..............................................................................................................
P20_kr_ck1 c5    ..............................................................................................................
P21_kr_hc1 c1    ..............................................................................................................
P21_kr_hc1 c2    ..............................................................T...............................................
P21_kr_hc1 c3    ..............................................................................................................
P21_kr_hc1 c4    ..............................................................................................................
P21_kr_hc1 c5    ..............................................................T...............................................
P24_kr_mh2 c1    ..............................................................................................................
P24_kr_mh2 c2    ..............................................................................................................
P24_kr_mh2 c3    ..............................................................T...............................................
P24_kr_mh2 c4    ..............................................................T...............................................
P25_kr_tb1 c1    ..............................................................................................................
P25_kr_tb1 c2    ..............................................................................................................
P25_kr_tb1 c3    ...........................................................................................C..................
P25_kr_tb1 c4    ..............................................................T...............................................
P25_kr_tb1 c5    ..............................................................T...............................................
P27_kr_so1 c1    ..............................................................................................................
P27_kr_so1 c2    ..............................................................T...............................................
P27_kr_so1 c3    ..............................................................T...............................................
P28_kr_il1 c1    ..............................................................................................................
P28_kr_il1 c2    ..............................................................................................................
P28_kr_il1 c3    ..............................................................................................................
P28_kr_il1 c4    ..............................................................T...............................................
P28_kr_il1 c5    ..............................................................T...............................................
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Appendix 1. (Continued).

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                                                                                                                            110
A1_kr_gr1 c1     TCGAAACCTGCACAAGCAGAAAGACCCGCGAACTCGTTTACAAACACCCGAGGGGCAGGGCTCGGCCAAAACCGGCGCTGCCCCTCACACCAACGAACCCCGGCGCGGAT
P29_kr_mj1 c1    ..............................................................T...............................................
P29_kr_mj1 c2    ..............................................................T...............................................
P29_kr_mj1 c3    ..............................................................................................................
P29_kr_mj2       ..............................................................................................................
P30_kr_dk1 c1    ..............................................................................................................
P30_kr_dk1 c2    ..............................................................................................................
P30_kr_dk1 c3    ..............................................................T...............................................
P30_kr_dk1 c4    ..............................................................T...............................................
P31_kr_jr1 c1    ..............................................................................................................
P31_kr_jr1 c2    ..............................................................T...............................................
P31_kr_jr1 c3    ..............................................................................................................
O1_jp_rb1 c1     ..............................................................T...............................................
O1_jp_rb1 c2     ..............................................................T...............................................
O1_jp_rb1 c3     ..............................................................T...............................................
O1_jp_rb1 c4     ..............................................................................................................
O1_jp_rb1 c5     ..............................................................................................................
O1_jp_rb1 c6     ............................T.................................................................................
O2_jp_hk2 c1     ..............................................................T...............................................
O2_jp_hk2 c2     ............................T.................................................................................
O2_jp_hk2 c3     ..............................................................................................................
O2_jp_hk2 c4     ..............................................................................................................
J1_jp_hn2 c1     ..............................................................T...............................................
B1_cn_bj1        ..............................................................................................................
B2_uk_1          ..............................................................................................................
SUF_hl_1         ........................................................G....C................C...............................
SUF_hl_2         ........................................................G....C................C...............................
AMP_cn1          ........................................................G....C.........Y......................................
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Appendix 1. (Continued).

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                                                                                                                                       220
A1_kr_gr1 c1      TGCGCCAAGGACCATGAACAATAGCGCGCCGCCCGCCACTCGGTCATCCGGTGTGCGAGCGGCGACGTGTCGTTTCGATAC-TAACTGAACGACTCTCGGCAACGGATAT
A1_kr_gr1 c2      .................................................................................-............................
A2_kr_hl3 c1      .................................................................................-............................
A2_kr_hl3 c2      .................................................................................-............................
A2_kr_hl5 c1      .................................................................................-............................
A2_kr_hl5 c2      .................................................................................-............................
A3_kr_hl5 c1      .................................................................................-............................
A3_kr_hl5 c2      .................................................................................-............................
A4_kr_hl9 c1      .................................................................................-............................
A4_kr_hl9 c2      .................................................................................-............................
A5_kr_hl10 c1     .................................................................................-............................
A5_kr_hl10 c2     .................................................................................-............................
A5_kr_hl10 c3     .................................................................................-............................
A5_kr_hl10 c4     .................................................................................-............................
A5_kr_hl10 c5     .................................................................................-............................
A5_kr_hl10 c6     .................................T...............................................-............................
A5_kr_hl11 c1     .................................................................................-............................
A5_kr_hl11 c2     .................................................................................-............................
A7_mn_1           .................................................................................-............................
A8_mn_2 c1        .................................................................................-............................
A8_mn_2 c2        .................................................................................-............................
M2_rs_kh1 c1      .................................................................................-............................
M2_rs_kh1 c2      .................................................................................-............................
M2_rs_kh3 c1      .................................................................................-.................A..........
M2_rs_kh3 c2      .................................................................................-............................
M2_rs_kh3 c3      .................................................................................-............................
M2_rs_kh3 c4      .................................................................................-............................
M3_rs_kh6 c1      .................................................................................-............................
M3_rs_kh6 c2      .................................................................................-............................
M3_rs_kh8 c1      .................................................................................-............................
M3_rs_kh8 c2      .................................................................................-............................
M3_rs_kh20 c1     .................................................................................-............................
M3_rs_kh20 c2     .................................................................................-............................
M3_rs_kh22        .................................................................................-............................
M3_rs_kh23 c1     .................................................................................-............................
M3_rs_kh23 c2     .................................................................................-............................
M3_rs_kh24        .................................................................................-............................
M3_rs_kh25 c1     .................................................................................-............................
M3_rs_kh25 c2     .................................................................................-............................
M3_rs_kh28 c1     .................................................................................-............................
M3_rs_kh28 c2     .................................................................................-............................
M3_rs_kh29        .................................................................................-............................
M3_rs_kh31 c1     .................................................................................-............................
M3_rs_kh31 c2     .................................................................................-.................A..........
M3_rs_kh31 c3     .................................................................................-............................
M3_rs_kh31_1 c1   .................................................................................-............................
M3_rs_kh31_2 c2   .................................................................................-............................
M4_rs_kh32 c1     .............................................................................-............................
M4_rs_kh32 c2     .................................................................................-............................
M5_rs_ot1         .................................................................................-............................
M6_rs_is2 c1      .................................................................................-............................
M6_rs_is2 c2      .................................................................................-............................
M7_cn_hj0 c1      .................................................................................-............................
M7_cn_hj0 c2      .................................................................................-............................
M8_cn_hj3_1 c1    .................................................................................-............................
M8_cn_hj3_1 c2    .................................................................................-............................
M8_cn_hj2         .................................................................................-............................
M8_cn_hj4         .................................................................................-............................
M8_cn_hj5 c1      .................................................................................-............................
M8_cn_hj5 c2      .................................................................................-............................
M9_cn_hj5         .................................................................................-............................
M13_kr_od c1      .................................................................................-............................
M13_kr_od c2      .................................................................................-............................
M13_kr_od c3      .................................................................................-............................
M14_kr_jm1 c1     .................................................................................-............................
M14_kr_jm1 c2     .................................................................................-............................
M16_kr_dr1 c1     .................................................................................-............................
M16_kr_dr1 c2     .................................................................................-............................
M18_kr_hg1 c1     .................................................................................-............................
M18_kr_hg1 c2     .................................................................................-............................
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Appendix 1. (Continued).

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                                                                                                                           220
A1_kr_gr1 c1    TGCGCCAAGGACCATGAACAATAGCGCGCCGCCCGCCACTCGGTCATCCGGTGTGCGAGCGGCGACGTGTCGTTTCGATAC-TAACTGAACGACTCTCGGCAACGGATAT
M20_kr_nh1 c1   .................................................................................-............................
M20_kr_nh1 c2   .................................................................................-............................
M20_kr_nh1 c3   .................................................................................-............................
M20_kr_nh1 c4   .................................................................................-............................
M21_kr_gu1 c1   .................................................................................-............................
M21_kr_gu1 c2   .................................................................................-............................
M21_kr_gu1 c3   .................................T...............................................-............................
M21_kr_gu1 c4   .................................................................................-............................
M22_kr_mp1 c1   .................................................................................-............................
M22_kr_mp1 c2   .................................................................................-............................
M25_kr_os2 c1   .................................................................................-............................
M25_kr_os2 c2   .................................................................................-............................
M25_kr_os3      .................................................................................-............................
M25_kr_os4 c1   .................................................................................-............................
M25_kr_os4 c2   .................................................................................-............................
M28_kr_bs1      .................................................................................-............................
M28_kr_bs2 c1   .................................................................................-............................
M28_kr_bs2 c2   .................................................................................-............................
M28_kr_bs2 c3   .................................................................................-............................
M30_kr_bl2 c1   .................................................................................-............................
M30_kr_bl2 c2   .................................................................................-............................
M32_kr_mt1 c1   .................................................................................-............................
M32_kr_mt1 c2   .................................................................................-............................
M33_kr_md2 c1   .................................................................................-............................
M33_kr_md2 c2   ...........................................................................T.....-............................
M34_kr_dn1 c1   .................................................................................-............................
M34_kr_dn1 c2   .................................................................................-............................
M34_kr_dn2 c1   .................................................................................-............................
M34_kr_dn2 c2   .................................................................................-............................
M35_kr_sm1 c1   .................................................................................-............................
M35_kr_sm1 c2   .................................................................................-............................
M35_kr_sm2 c1   .................................................................................-............................
M35_kr_sm2 c2   .................................................................................-............................
P1_rs_ms1 c1    .................................................................................C............................
P1_rs_ms1 c2    .................................................................................-............................
P1_rs_ms3 c1    .................................................................................-............................
P1_rs_ms3 c2    .................................................................................-............................
P1_rs_ms3 c3    .................................................................................C............................
P1_rs_ms3 c4    .................................................................................C............................
P1_rs_ms3 c5    .................................................................................-............................
P2_rs_nk2       .................................................................................-............................
P3_rs_pr1       .................................................................................-............................
P4_rs_pr2 c1    .................................................................................-............................
P4_rs_pr2 c2    .................................................................................-............................
P4_rs_pr2 c3    .................................................................................-............................
P4_rs_pr3 c1    .................................................................................-............................
P4_rs_pr3 c2    .................................................................................-............................
P5_rs_rc1 c1    .................................................................................-............................
P5_rs_rc1 c2    .................................................................................-............................
P5_rs_rc1 c3    ..................................................................A..............-............................
P5_rs_rc1 c4    .................................G...............................................-............................
P5_rs_rc1 c5    .................................................................................-............................
P6_rs_rc7       .................................................................................-............................
P7_rs_us1 c1    .................................................................................-............................
P7_rs_us2 c1    .................................................................................-............................
P7_rs_us2 c2    .................................................................................-............................
P7_rs_us2 c3    .................................................................................-............................
P7_rs_us2 c4    .................................................................................-............................
P7_rs_us2 c5    .................................................................................-............................
P9_rs_pr5       .................................................................................-............................
P10_cn_jl1 c1   .................................................................................-............................
P10_cn_jl1 c2   .................................................................................-............................
P11_cn_jl3 c1   .................................................................................-............................
P11_cn_jl3 c2   .................................................................................-............................
P11_cn_jl4 c1   .................................................................................-............................
P11_cn_jl4 c2   .................................................................................-............................
P12_cn_sn2 c1   .................................................................................-............................
P12_cn_sn2 c2   .................................................................................-............................
P12_cn_sn2 c3   .................................................................................-............................
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Appendix 1. (Continued).

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                                                                                                                            220
A1_kr_gr1 c1    TGCGCCAAGGACCATGAACAATAGCGCGCCGCCCGCCACTCGGTCATCCGGTGTGCGAGCGGCGACGTGTCGTTTCGATAC-TAACTGAACGACTCTCGGCAACGGATAT
P12_cn_sn2 c4   .................................................................................-............................
P13_cn_mc1 c1   .................................................................................-............................
P13_cn_mc1 c2   .................................................................................-............................
P13_cn_mc1 c3   .................................................................................-............................
P13_cn_mc2 c1   .................................................................................-............................
P13_cn_mc2 c2   .................................................................................-............................
P13_cn_mc2 c3   .................................................................................-............................
P13_cn_mc2 c4   .................................................................................-............................
P14_kr_hw1 c1   .................................................................................-............................
P14_kr_hw1 c2   .................................................................................-............................
P14_kr_hw1 c3   .................................................................................-............................
P15_kr_dm1 c1   .................................................................................-............................
P15_kr_dm1 c2   .................................................................................-............................
P15_kr_dm1 c3   .................................................................................-............................
P16_kr_sk2 c1   .................................................................................-............................
P16_kr_sk2 c2   .................................................................................-............................
P16_kr_sk2 c3   .............................................G...................................-............................
P16_kr_sk5 c1   .................................................................................-............................
P16_kr_sk5 c2   .................................................................................-............................
P17_kr_sh1 c1   .................................................................................-............................
P17_kr_sh1 c2   .................................................................................-............................
P17_kr_sh1 c3   .................................................................................-............................
P17_kr_sh1 c4   .................................................................................-............................
P17_kr_sh1 c5   .............................................G...................................-............................
P17_kr_sh1 c6   .................................................................................-............................
P19_kr_gw1 c1   .................................................................................-............................
P19_kr_gw1 c2   .................................................................................-............................
P19_kr_gw1 c3   .................................................................................-............................
P19_kr_gw1 c4   .................................................................................-............................
P19_kr_gw3 c1   .................................................................................-............................
P19_kr_gw3 c2   .................................................................................-............................
P19_kr_gw3 c3   .................................................................................-............................
P20_kr_ck1 c1   .................................................................................-............................
P20_kr_ck1 c2   .................................................................................-............................
P20_kr_ck1 c3   .................................................................................-............................
P20_kr_ck1 c4   .................................................................................-............................
P20_kr_ck1 c5   .................................................................................-............................
P21_kr_hc1      .................................................................................-............................
P24_kr_mh2 c1   .................................................................................-............................
P24_kr_mh2 c2   .................................................................................-............................
P24_kr_mh2 c3   .................................................................................-............................
P24_kr_mh2 c4   .................................................................................-............................
P21_kr_hc1 c1   .................................................................................-............................
P21_kr_hc1 c2   .................................................................................-............................
P21_kr_hc1 c3   .................................................................................-............................
P21_kr_hc1 c4   .................................................................................-............................
P25_kr_tb1 c1   .................................................................................-............................
P25_kr_tb1 c2   .................................................................................-............................
P25_kr_tb1 c3   .................................................................................-............................
P25_kr_tb1 c4   .................................................................................-............................
P25_kr_tb1 c5   .................................................................................-............................
P27_kr_so1 c1   .............................................G...................................-............................
P27_kr_so1 c2   .................................................................................-............................
P27_kr_so1 c3   .................................................................................-............................
P28_kr_il1 c1   .............................................G...................................-............................
P28_kr_il1 c2   .................................................................................-............................
P28_kr_il1 c3   .................................................................................-............................
P28_kr_il1 c4   .................................................................................-............................
P28_kr_il1 c5   .................................................................................-............................
P29_kr_mj1 c1   .................................................................................-............................
P29_kr_mj1 c2   .................................................................................-............................
P29_kr_mj1 c3   .................................................................................-............................
P29_kr_mj2      .................................................................................-............................
P30_kr_dk1 c1   .................................................................................-............................
P30_kr_dk1 c2   .................................................................................-............................
P30_kr_dk1 c3   .................................................................................-............................
P30_kr_dk1 c4   .................................................................................-............................
P31_kr_jr1 c1   .................................................................................-............................
P31_kr_jr1 c2   .................................................................................-............................
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Appendix 1. (Continued).

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                                                                                                                            220
A1_kr_gr1 c1     TGCGCCAAGGACCATGAACAATAGCGCGCCGCCCGCCACTCGGTCATCCGGTGTGCGAGCGGCGACGTGTCGTTTCGATAC-TAACTGAACGACTCTCGGCAACGGATAT
P31_kr_jr1 c3    .................................................................................-............................
O1_jp_rb1 c1     .................................................................................C............................
O1_jp_rb1 c2     .................................................................................-............................
O1_jp_rb1 c3     .................................................................................-............................
O1_jp_rb1 c4     .................................................................................-............................
O1_jp_rb1 c5     .................................................................................-............................
O1_jp_rb1 c6     .................................................................................-............................
O2_jp_hk2 c1     .................................................................................-............................
O2_jp_hk2 c2     .................................................................................-............................
O2_jp_hk2 c3     .................................................................................-............................
O2_jp_hk2 c4     .................................................................................-............................
J1_jp_hn2        .................................................................................-............................
B1_cn_bj1        .................................................................................-............................
B2_uk_1          .................................................................................-............................
SUF_hl_1         .....................................G.C...........CK...........G................-....Y.......................
SUF_hl_2         .....................................G.C...........C............G................-....Y.......................
AMP_cn1          .................................................................................-............................
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Appendix 1. (Continued).

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                                                                                                                           330
A1_kr_gr1 c1    CTCGGCTCTCGCATCGATGAAGAACGTAGCGAAATGCGATACTTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTCTTTGAACGCAAGTTGCGCCCGAAGCCTTCGG
A1_kr_gr1 c2    ..............................................................................................................
A2_kr_hl5 c1    ..............................................................................................................
A2_kr_hl5 c2    ..............................................................................................................
A2_kr_hl3 c1    ............................................................................................................
A2_kr_hl3 c2    ..............................................................................................................
A3_kr_hl5 c1    ..............................................................................................................
A3_kr_hl5 c2    ..............................................................................................................
A4_kr_hl9 c1    ..............................................................................................................
A4_kr_hl9 c2    ..............................................................................................................
A5_kr_hl10 c1   ..............................................................................................................
A5_kr_hl10 c2   ..............................................................................................................
A5_kr_hl10 c3   ..............................................................................................................
A5_kr_hl10 c4   ..............................................................................................................
A5_kr_hl10 c5   ..............................................................................................................
A5_kr_hl10 c6   ..............................................................................................................
A5_kr_hl11 c1   ..............................................................................................................
A5_kr_hl11 c2   ..............................................................................................................
A7_mn_1         ..............................................................................................................
A8_mn_2 c1      ..............................................................................................................
A8_mn_2 c2      ..............................................................................................................
M2_rs_kh1 c1    ..............................................................................................................
M2_rs_kh1 c2    ..............................................................................................................
M2_rs_kh3 c1    ..............................................................................................................
M2_rs_kh3 c2    ..............................................................................................................
M2_rs_kh3 c3    ..............................................................................................................
M2_rs_kh3 c4    ..............................................................................................................
M3_rs_kh6 c1    ..............................................................................................................
M3_rs_kh6 c2    ..............................................................................................................
M3_rs_kh8 c1    ..............................................................................................................
M3_rs_kh8 c2    ..............................................................................................................
M3_rs_kh20 c1   ..............................................................................................................
M3_rs_kh20 c2   ..............................................................................................................
M3_rs_kh22      ..............................................................................................................
M3_rs_kh23 c1   ..............................................................................................................
M3_rs_kh23 c2   ..............................................................................................................
M3_rs_kh24      ..............................................................................................................
M3_rs_kh25 c1   ..............................................................................................................
M3_rs_kh25 c2   ..............................................................................................................
M3_rs_kh28 c1   ..............................................................................................................
M3_rs_kh28 c2   ..............................................................................................................
M3_rs_kh29      ..............................................................................................................
M3_rs_kh31 c1   ..............................................................................................................
M3_rs_kh31 c2   ..............................................................................................................
M3_rs_kh31 c3   ..............................................................................................................
M3_rs_kh31_1 c1 ..............................................................................................................
M3_rs_kh31_1 c2 ..............................................................................................................
M4_rs_kh32 c1   ..............................................................................................................
M4_rs_kh32 c2   ..............................................................................................................
M5_rs_ot1       ..............................................................................................................
M6_rs_is2 c1    ..............................................................................................................
M6_rs_is2 c2    ..............................................................................................................
M7_cn_hj0 c1    ..............................................................................................................
M7_cn_hj0 c2    ..............................................................................................................
M8_cn_hj3_1 c1  ..............................................................................................................
M8_cn_hj3_1 c2  ..............................................................................................................
M8_cn_hj2       ..............................................................................................................
M8_cn_hj4       ..............................................................................................................
M8_cn_hj5 c1    ..............................................................................................................
M8_cn_hj5 c2    ..............................................................................................................
M9_cn_hj5       ..............................................................................................................
M13_kr_od c1    ..............................................................................................................
M13_kr_od c2    ..............................................................................................................
M13_kr_od c3    ..............................................................................................................
M14_kr_jm1 c1   ..............................................................................................................
M14_kr_jm1 c2   ..............................................................................................................
M16_kr_dr1 c1   ..............................................................................................................
M16_kr_dr1 c2   ..............................................................................................................
M18_kr_hg1 c1   ..............................................................................................................
M18_kr_hg1 c2   ..............................................................................................................
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Appendix 1. (Continued).

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                                                                                                                            330
A1_kr_gr1 c1     CTCGGCTCTCGCATCGATGAAGAACGTAGCGAAATGCGATACTTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTCTTTGAACGCAAGTTGCGCCCGAAGCCTTCGG
M20_kr_nh1 c1    ..............................................................................................................
M20_kr_nh1 c2    ..............................................................................................................
M20_kr_nh1 c3    ..............................................................................................................
M20_kr_nh1 c4    ..............................................................................................................
M21_kr_gu1 c1    ..............................................................................................................
M21_kr_gu1 c2    ..............................................................................................................
M21_kr_gu1 c3    ..............................................................................................................
M21_kr_gu1 c4    ..............................................................................................................
M22_kr_mp1 c1    ..............................................................................................................
M22_kr_mp1 c2    ..............................................................................................................
M25_kr_os2 c1    ..............................................................................................................
M25_kr_os2 c2    ..............................................................................................................
M25_kr_os3       ..............................................................................................................
M25_kr_os4 c1    ..............................................................................................................
M25_kr_os4 c2    ..............................................................................................................
M28_kr_bs2 c1    ..............................................................................................................
M28_kr_bs2 c2    ..............................................................................................................
M28_kr_bs2 c3    ..............................................................................................................
M28_kr_bs1 c4    ..............................................................................................................
M30_kr_bl2 c1    ..............................................................................................................
M30_kr_bl2 c2    ..............................................................................................................
M32_kr_mt1 c1    ..............................................................................................................
M32_kr_mt1 c2    ..............................................................................................................
M33_kr_md2 c1    ..............................................................................................................
M33_kr_md2 c2    ..............................................................................................................
M34_kr_dn1 c1    ..............................................................................................................
M34_kr_dn1 c2    ..............................................................................................................
M34_kr_dn2 c1    ..............................................................................................................
M34_kr_dn2 c2    ..............................................................................................................
M35_kr_sm1 c1    ..............................................................................................................
M35_kr_sm1 c2    ..............................................................................................................
M35_kr_sm2 c1    ..............................................................................................................
M35_kr_sm2 c2    ..............................................................................................................
P1_rs_ms1 c1     ..............................................................................................................
P1_rs_ms1 c2     ..............................................................................................................
P1_rs_ms3 c1     ..............................................................................................................
P1_rs_ms3 c2     ..............................................................................................................
P1_rs_ms3 c3     ..............................................................................................................
P1_rs_ms3 c4     ..............................................................................................................
P1_rs_ms3 c5     ..............................................................................................................
P2_rs_nk2        ..............................................................................................................
P3_rs_pr1        ..............................................................................................................
P4_rs_pr2 c1     ..............................................................................................................
P4_rs_pr2 c2     ..............................................................................................................
P4_rs_pr2 c3     ..............................................................................................................
P4_rs_pr3 c1     ..............................................................................................................
P4_rs_pr3 c2     ..............................................................................................................
P5_rs_rc1 c1     ..............................................................................................................
P5_rs_rc1 c2     ..............................................................................................................
P5_rs_rc1 c3     ..............................................................................................................
P5_rs_rc1 c4     ..............................................................................................................
P5_rs_rc1 c5     ..............................................................................................................
P6_rs_rc7        ..............................................................................................................
P7_rs_us1        ..............................................................................................................
P7_rs_us2 c1     ..............................................................................................................
P7_rs_us2 c2     ..............................................................................................................
P7_rs_us2 c3     ..............................................................................................................
P7_rs_us2 c4     ..............................................................................................................
P7_rs_us2 c5     ..............................................................................................................
P9_rs_pr5        ..............................................................................................................
P10_cn_jl1 c1    ..............................................................................................................
P10_cn_jl1 c2    ..............................................................................................................
P11_cn_jl3 c1    ..............................................................................................................
P11_cn_jl3 c2    ..............................................................................................................
P11_cn_jl4 c1    ..............................................................................................................
P11_cn_jl4 c2    ..............................................................................................................
P12_cn_sn2 c1    ..............................................................................................................
P12_cn_sn2 c2    ..............................................................................................................
P12_cn_sn2 c3    ..............................................................................................................
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Appendix 1. (Continued).

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                                                                                                                           330
A1_kr_gr1 c1    CTCGGCTCTCGCATCGATGAAGAACGTAGCGAAATGCGATACTTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTCTTTGAACGCAAGTTGCGCCCGAAGCCTTCGG
P12_cn_sn2 c4   ..............................................................................................................
P13_cn_mc1 c1   ..............................................................................................................
P13_cn_mc1 c2   ..............................................................................................................
P13_cn_mc1 c3   ..............................................................................................................
P13_cn_mc2 c1   ..............................................................................................................
P13_cn_mc2 c2   ..............................................................................................................
P13_cn_mc2 c3   ..............................................................................................................
P13_cn_mc2 c4   ..............................................................................................................
P14_kr_hw1 c1   ..............................................................................................................
P14_kr_hw1 c2   ..............................................................................................................
P14_kr_hw1 c3   ..............................................................................................................
P15_kr_dm1 c1   ..............................................................................................................
P15_kr_dm1 c2   ..............................................................................................................
P15_kr_dm1 c3   ..............................................................................................................
P16_kr_sk2 c1   ..............................................................................................................
P16_kr_sk2 c2   ..............................................................................................................
P16_kr_sk2 c3   ..............................................................................................................
P16_kr_sk5 c1   ..............................................................................................................
P16_kr_sk5 c2   ..............................................................................................................
P17_kr_sh1 c1   ..............................................................................................................
P17_kr_sh1 c2   ..............................................................................................................
P17_kr_sh1 c3   ..............................................................................................................
P17_kr_sh1 c4   ..............................................................................................................
P17_kr_sh1 c5   ..............................................................................................................
P17_kr_sh1 c6   ...........................................................................................................A..
P19_kr_gw3 c1   ..............................................................................................................
P19_kr_gw3 c2   ..............................................................................................................
P19_kr_gw3 c3   ..............................................................................................................
P19_kr_gw1 c1   ..............................................................................................................
P19_kr_gw1 c2   ..............................................................................................................
P19_kr_gw1 c3   ..............................................................................................................
P19_kr_gw1 c4   ..............................................................................................................
P20_kr_ck1 c1   ..............................................................................................................
P20_kr_ck1 c2   ..............................................................................................................
P20_kr_ck1 c3   ..............................................................................................................
P20_kr_ck1 c4   ..............................................................................................................
P20_kr_ck1 c5   ..............................................................................................................
P21_kr_hc1      ..............................................................................................................
P24_kr_mh2 c1   ..............................................................................................................
P24_kr_mh2 c2   ..............................................................................................................
P24_kr_mh2 c3   ..............................................................................................................
P24_kr_mh2 c4   ..............................................................................................................
P21_kr_hc1 c1   ..............................................................................................................
P21_kr_hc1 c2   ..............................................................................................................
P21_kr_hc1 c3   ..............................................................................................................
P21_kr_hc1 c4   ..............................................................................................................
P25_kr_tb1 c1   ..............................................................................................................
P25_kr_tb1 c2   ..............................................................................................................
P25_kr_tb1 c3   ..............................................................................................................
P25_kr_tb1 c4   ..............................................................................................................
P25_kr_tb1 c5   ..............................................................................................................
P27_kr_so1 c1   ..............................................................................................................
P27_kr_so1 c2   ..............................................................................................................
P27_kr_so1 c3   ..............................................................................................................
P28_kr_il1 c1   ..............................................................................................................
P28_kr_il1 c2   ..............................................................................................................
P28_kr_il1 c3   ..............................................................................................................
P28_kr_il1 c4   ..............................................................................................................
P28_kr_il1 c5   ..............................................................................................................
P29_kr_mj2 c1   ..............................................................................................................
P29_kr_mj1 c2   ..............................................................................................................
P29_kr_mj1 c3   ..............................................................................................................
P29_kr_mj1 c4   ..............................................................................................................
P30_kr_dk1 c1   ..............................................................................................................
P30_kr_dk1 c2   ..............................................................................................................
P30_kr_dk1 c3   ..............................................................................................................
P30_kr_dk1 c4   ..............................................................................................................
P31_kr_jr1 c1   ..............................................................................................................
P31_kr_jr1 c2   ..............................................................................................................
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Appendix 1. (Continued).

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                                                                                                                       330
A1_kr_gr1 c1    CTCGGCTCTCGCATCGATGAAGAACGTAGCGAAATGCGATACTTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTCTTTGAACGCAAGTTGCGCCCGAAGCCTTCGG
P31_kr_jr1 c3   ..............................................................................................................
O1_jp_rb1 c1    ..............................................................................................................
O1_jp_rb1 c2    ..............................................................................................................
O1_jp_rb1 c3    ..............................................................................................................
O1_jp_rb1 c4    ..............................................................................................................
O1_jp_rb1 c5    ..............................................................................................................
O1_jp_rb1 c6    ..............................................................................................................
O2_jp_hk2 c1    ..............................................................................................................
O2_jp_hk2 c2    ..............................................................................................................
O2_jp_hk2 c3    ..............................................................................................................
O2_jp_hk2 c4    ..............................................................................................................
J1_jp_hn2       ..............................................................................................................
B1_cn_bj1       ..............................................................................................................
B2_uk_1         ..............................................................................................................
SUF_hl_1        ..............................................................................................................
SUF_hl_2        ..............................................................................................................
AMP_cn1         ..............................................................................................................
```

Appendix 1. (Continued).

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                                                                                                                            440
A1_kr_gr1 c1     GCCGAGGGCACGTCTGCATGGGCGTCACGCACAGCGTCGCCCCCACCCCATCCCGTGGGGCGTGGGGCGGATTCTGGCCCCCCGTGTGCTCCCGCGCGCGGTCGGCCTAA
A1_kr_gr1 c2     ..............................................................................................................
A2_kr_hl3 c1     ..............................................................A...............................................
A2_kr_hl3 c2     ..............................................................................................................
A2_kr_hl5 c1     ..............................................................................................................
A2_kr_hl5 c2     ..............................................................................................................
A3_kr_hl5 c1     ..............................................................................................................
A3_kr_hl5 c2     ....................................................T.........................................................
A4_kr_hl9 c1     ..............................................................................................................
A4_kr_hl9 c2     ....................................................T.........................................................
A5_kr_hl10 c1    ..............................................................................................................
A5_kr_hl10 c2    ....................................................T.........................................................
A5_kr_hl10 c3    ....................................................T.........................................................
A5_kr_hl10 c4    ..............................................................................................................
A5_kr_hl10 c5    ..............................................................................................................
A5_kr_hl10 c6    ..............................................................A...............................................
A5_kr_hl11 c1    ..............................................................A...............................................
A5_kr_hl11 c2    ..............................................................................................................
A7_mn_1          ..............................................................................................................
A8_mn_2 c1       ..............................................................................................................
A8_mn_2 c2       ..............................................................................................................
M2_rs_kh1 c1     ..............................................................................................................
M2_rs_kh1 c2     ..............................................................................................................
M2_rs_kh3 c1     ..............................................................A...............................................
M2_rs_kh3 c2     ..............................................................................................................
M2_rs_kh3 c3     ..............................................................................................................
M2_rs_kh3 c4     ..............................................................................................................
M3_rs_kh6 c1     ..............................................................A...............................................
M3_rs_kh6 c2     ..............................................................................................................
M3_rs_kh8 c1     ..............................................................A...............................................
M3_rs_kh8 c2     ..............................................................................................................
M3_rs_kh20 c1    ..............................................................A...............................................
M3_rs_kh20 c2    ..............................................................................................................
M3_rs_kh22 c1    ..............................................................................................................
M3_rs_kh23 c1    ..............................................................A...............................................
M3_rs_kh23 c2    ..............................................................................................................
M3_rs_kh24       ..............................................................................................................
M3_rs_kh25 c1    ..............................................................A...............................................
M3_rs_kh25 c2    ..............................................................................................................
M3_rs_kh28 c1    ..............................................................A...............................................
M3_rs_kh28 c2    ..............................................................................................................
M3_rs_kh29       ..............................................................................................................
M3_rs_kh31 c1    ..............................................................................................................
M3_rs_kh31 c2    ..............................................................................................................
M3_rs_kh31 c3    ..............................................................................................................
M3_rs_kh31_1 c1  ..............................................................A...............................................
M3_rs_kh31_2 c2  ..............................................................................................................
M4_rs_kh32 c1    ..............................................................................................................
M4_rs_kh32 c2    ..............................................................................................................
M5_rs_ot1        ..............................................................................................................
M6_rs_is2 c1     ..............................................................................................................
M6_rs_is2 c2     ..............................................................................................................
M7_cn_hj0 c1     ..............................................................................................................
M7_cn_hj0 c2     ....................................................T.........................................................
M8_cn_hj2        ..............................................................................................................
M8_cn_hj4        ..............................................................................................................
M8_cn_hj5 c1     ..............................................................................................................
M8_cn_hj5 c2     ..............................................................................................................
M8_cn_hj3_1 c1   ..............................................................................................................
M8_cn_hj3_1 c2   ..............................................................................................................
M9_cn_hj5        ..............................................................................................................
M13_kr_od c1     ..............................................................A...............................................
M13_kr_od c2     ..............................................................................................................
M13_kr_od c3     ....................................................T.........................................................
M14_kr_jm1 c1    ....................................................T.........................................................
M14_kr_jm1 c2    ....................................................T.........................................................
M16_kr_dr1 c1    ..............................................................................................................
M16_kr_dr1 c2    ....................................................T.........................................................
M18_kr_hg1 c1    ..............................................................................................................
M18_kr_hg1 c2    ....................................................T.........................................................
```

Appendix 1. (Continued).

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                                                                                                                           440
A1_kr_gr1 c1    GCCGAGGGCACGTCTGCATGGGCGTCACGCACAGCGTCGCCCCCACCCCATCCCGTGGGGCGTGGGGCGGATTCTGGCCCCCCGTGTGCTCCCGCGCGCGGTCGGCCTAA
M20_kr_nh1 c1   ..............................................................................................................
M20_kr_nh1 c2   ....................................................T.........................................................
M20_kr_nh1 c3   ....................................................T.........................................................
M20_kr_nh1 c4   ..............................................................................................................
M21_kr_gu1 c1   ..............................................................................................................
M21_kr_gu1 c2   ....................................................T.........................................................
M21_kr_gu1 c3   ..............................................................A...............................................
M21_kr_gu1 c4   ..............................................................A...............................................
M22_kr_mp1 c1   ..............................................................A...............................................
M22_kr_mp1 c2   ..............................................................................................................
M25_kr_os2 c1   ..............................................................A...............................................
M25_kr_os2 c2   ..............................................................................................................
M25_kr_os3      ....................................................T.........................................................
M25_kr_os4 c1   ..............................................................A...............................................
M25_kr_os4 c2   ..............................................................................................................
M28_kr_bs2 c1   ....................................................T.........................................................
M28_kr_bs2 c2   ..............................................................................................................
M28_kr_bs2 c3   ..............................................................................................................
M28_kr_bs1 c4   ..............................................................................................................
M30_kr_bl2 c1   ..............................................................................................................
M30_kr_bl2 c2   ..............................................................................................................
M32_kr_mt1 c1   ..............................................................................................................
M32_kr_mt1 c2   ..............................................................................................................
M33_kr_md2 c1   ..............................................................................................................
M33_kr_md2 c2   ..............................................................................................................
M34_kr_dn1 c1   ..............................................................................................................
M34_kr_dn1 c2   ....................................................T.........................................................
M34_kr_dn2 c1   ..............................................................................................................
M34_kr_dn2 c2   ..............................................................................................................
M35_kr_sm1 c1   ..............................................................................................................
M35_kr_sm1 c2   ..............................................................................................................
M35_kr_sm2 c1   ..............................................................A...............................................
M35_kr_sm2 c2   ..............................................................................................................
P1_rs_ms1 c1    ..............................................................................................................
P1_rs_ms1 c2    ..............................................................................................................
P1_rs_ms3 c1    ..............................................................................................................
P1_rs_ms3 c2    ..............................................................................................................
P1_rs_ms3 c3    ....................................................T.........................................................
P1_rs_ms3 c4    ..............................................................................................................
P1_rs_ms3 c5    ..............................................................................................................
P2_rs_nk2       ..............................................................................................................
P3_rs_pr1 c1    ..............................................................................................................
P4_rs_pr2 c2    ..............................................................................................................
P4_rs_pr2 c3    ..............................................................................................................
P4_rs_pr2 c4    ..............................................................................................................
P4_rs_pr3 c5    ..............................................................................................................
P4_rs_pr3 c5    ..............................................................................................................
P5_rs_rc1 c1    ....................................................T.........................................................
P5_rs_rc1 c2    ..............................................................................................................
P5_rs_rc1 c3    ..............................................................................................................
P5_rs_rc1 c4    ..............................................................................................................
P5_rs_rc1 c5    ..............................................................................................................
P6_rs_rc7       ..............................................................................................................
P7_rs_us1       ..............................................................................................................
P7_rs_us2 c1    ..............................................................................................................
P7_rs_us2 c2    ..............................................................................................................
P7_rs_us2 c3    ..............................................................................................................
P7_rs_us2 c4    ..............................................................................................................
P7_rs_us2 c5    ..............................................................................................................
P9_rs_pr5       ..............................................................................................................
P10_cn_jl1 c1   ..............................................................................................................
P10_cn_jl1 c2   ..............................................................................................................
P11_cn_jl3 c1   ..............................................................................................................
P11_cn_jl3 c2   ....................................................T.........................................................
P11_cn_jl4 c1   ..................................................T.........................................................
P11_cn_jl4 c2   ..............................................................................................................
P12_cn_sn2 c1   ....................................................T.........................................................
P12_cn_sn2 c2   ..............................................................................................................
P12_cn_sn2 c3   ..............................................................................................................
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Appendix 1. (Continued).

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                                                                                                                           440
A1_kr_gr1 c1    GCCGAGGGCACGTCTGCATGGGCGTCACGCACAGCGTCGCCCCCACCCCATCCCGTGGGGCGTGGGGCGGATTCTGGCCCCCCGTGTGCTCCCGCGCGCGGTCGGCCTAA
P12_cn_sn2 c4   ..............................................................................................................
P13_cn_mc1 c1   ..............................................................................................................
P13_cn_mc1 c2   ..............................................................................................................
P13_cn_mc1 c3   ..............................................................................................................
P13_cn_mc2 c1   ....................................................T.........................................................
P13_cn_mc2 c2   ....................................................T.........................................................
P13_cn_mc2 c3   ..............................................................................................................
P13_cn_mc2 c4   ..............................................................................................................
P14_kr_hw1 c1   ..............................................................................................................
P14_kr_hw1 c2   ....................................................T.........................................................
P14_kr_hw1 c3   ....................................................T.........................................................
P15_kr_dm1 c1   ....................................................T.........................................................
P15_kr_dm1 c2   ....................................................T.........................................................
P15_kr_dm1 c3   ..............................................................................................................
P16_kr_sk2 c1   ....................................................T.........................................................
P16_kr_sk2 c2   ....................................................T.........................................................
P16_kr_sk2 c3   ..............................................................................................................
P16_kr_sk5 c1   ....................................................T.........................................................
P16_kr_sk5 c2   ....................................................T.........................................................
P17_kr_sh1 c1   ..............................................................................................................
P17_kr_sh1 c2   ..............................................................................................................
P17_kr_sh1 c3   ....................................................T.........................................................
P17_kr_sh1 c4   ....................................................T.........................................................
P17_kr_sh1 c5   ..............................................................................................................
P17_kr_sh1 c6   ....................................................T.........................................................
P19_kr_gw3 c1   ..............................................................................................................
P19_kr_gw3 c2   ....................................................T.........................................................
P19_kr_gw3 c3   ....................................................T.........................................................
P19_kr_gw1 c1   ....................................................T.........................................................
P19_kr_gw1 c2   ..............................................................................................................
P19_kr_gw1 c3   ....................................................T.........................................................
P19_kr_gw1 c4   ....................................................T.........................................................
P20_kr_ck1 c1   ..............................................................................................................
P20_kr_ck1 c2   ....................................................T.........................................................
P20_kr_ck1 c3   ....................................................T.........................................................
P20_kr_ck1 c4   ..............................................................................................................
P20_kr_ck1 c5   ....................................................T.........................................................
P21_kr_hc1 c1   ..............................................................A...............................................
P24_kr_mh2 c1   ..............................................................A...............................................
P24_kr_mh2 c2   ..............................................................................................................
P24_kr_mh2 c3   ....................................................T.........................................................
P24_kr_mh2 c4   ..............................................................................................................
P21_kr_hc1 c1   ..............................................................................................................
P21_kr_hc1 c2   ....................................................T.........................................................
P21_kr_hc1 c3   ..............................................................................................................
P21_kr_hc1 c4   ....................................................T.........................................................
P25_kr_tb1 c1   ..............................................................................................................
P25_kr_tb1 c2   ....................................................T.........................................................
P25_kr_tb1 c3   ..............................................................................................................
P25_kr_tb1 c4   ....................................................T.........................................................
P25_kr_tb1 c5   ....................................................T.........................................................
P27_kr_so1 c1   ..............................................................................................................
P27_kr_so1 c2   ....................................................T.........................................................
P27_kr_so1 c3   ..............................................................................................................
P28_kr_il1 c1   ..............................................................................................................
P28_kr_il1 c2   ..............................................................................................................
P28_kr_il1 c3   ....................................................T.........................................................
P28_kr_il1 c4   ..............................................................................................................
P28_kr_il1 c5   ....................................................T.........................................................
P29_kr_mj1 c1   ....................................................T.........................................................
P29_kr_mj1 c2   ..............................................................................................................
P29_kr_mj1 c3   ..............................................................................................................
P29_kr_mj2      ....................................................T.........................................................
P30_kr_dk1 c1   ....................................................T.........................................................
P30_kr_dk1 c2   ..............................................................................................................
P30_kr_dk1 c3   ..............................................................................................................
P30_kr_dk1 c4   ....................................................T.........................................................
P31_kr_jr1 c1   ....................................................T.........................................................
P31_kr_jr1 c2   ....................................................T.........................................................
```

Appendix 1. (Continued).

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                                                                                                                             440
A1_kr_gr1 c1      GCCGAGGGCACGTCTGCATGGGCGTCACGCACAGCGTCGCCCCCACCCCATCCCGTGGGGCGTGGGGCGGATTCTGGCCCCCCGTGTGCTCCCGCGCGCGGTCGGCCTAA
P31_kr_jr1 c3     ..............................................................................................................
O1_jp_rb1 c1      ..............................................................................................................
O1_jp_rb1 c2      ..............................................................................................................
O1_jp_rb1 c3      ...........................................................................................................A..
O1_jp_rb1 c4      ...........................................................................................................A..
O1_jp_rb1 c5      ..............................................................................................................
O1_jp_rb1 c6      ..............................................................................................................
O2_jp_hk2 c1      ..............................................................................................................
O2_jp_hk2 c2      ..............................................................................................................
O2_jp_hk2 c1      ..............................................................................................................
O2_jp_hk2 c2      ..............................................................................................................
J1_jp_hn2         ..............................................................................................................
B1_cn_bj1         ..............................................................................................................
B2_uk_1           ..............................................................................................................
SUF_hl_1          .................................................G-.T.........................................................
SUF_hl_2          .................................................G-.T.........................................................
AMP_cn1           ..................................................-.T.........................................................
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Appendix 1. (Continued).

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                                                                                                                            550
A1_kr_gr1 c1     AATCAGACCCCGTGGCCGCGAAATGCCGCGACGATTGGTGGTGTACGTGGCAGCCTCGTGCCGCCTAACATCGCGTCGCGCCTTCCGTGGCCCTCTGGAGTAAAAAGGAC
A1_kr_gr1 c2     ..............................................................................................................
A2_kr_hl3 c1     ..............................................................................................................
A2_kr_hl3 c2     ..............................................................................................................
A2_kr_hl5 c1     ..............................................................................................................
A2_kr_hl5 c2     ..............................................................................................................
A3_kr_hl5 c1     ..............................................................................................................
A3_kr_hl5 c2     ..............................................................................................................
A4_kr_hl9 c1     ..............................................................................................................
A4_kr_hl9 c2     ..............................................................................................................
A5_kr_hl10 c1    ..............................................................................................................
A5_kr_hl10 c2    ..............................................................................................................
A5_kr_hl10 c3    ..............................................................................................................
A5_kr_hl10 c4    ..............................................................................................................
A5_kr_hl10 c5    ..............................................................................................................
A5_kr_hl10 c6    ..............................................................................................................
A5_kr_hl11 c1    ..............................................................................................................
A5_kr_hl11 c2    ..............................................................................................................
A7_mn_1          .................................................................G............................................
A8_mn_2 c1       .................................................................G............................................
A8_mn_2 c2       ..............................................................................................................
M2_rs_kh1 c1     ..............................................................................................................
M2_rs_kh1 c2     ..............................................................................................................
M2_rs_kh3 c1     ..............................................................................................................
M2_rs_kh3 c2     ..............................................................................................................
M2_rs_kh3 c3     ..............................................................................................................
M2_rs_kh3 c4     ....................................................................................T.........................
M3_rs_kh6 c1     ..............................................................................................................
M3_rs_kh6 c2     ..............................................................................................................
M3_rs_kh8 c1     ..............................................................................................................
M3_rs_kh8 c2     ..............................................................................................................
M3_rs_kh20 c1    ..............................................................................................................
M3_rs_kh20 c2    ..............................................................................................................
M3_rs_kh22 c1    ..............................................................................................................
M3_rs_kh23 c2    ..............................................................................................................
M3_rs_kh23 c3    ..............................................................................................................
M3_rs_kh24       ..............................................................................................................
M3_rs_kh25 c1    ..............................................................................................................
M3_rs_kh25 c2    ..............................................................................................................
M3_rs_kh28 c1    ..............................................................................................................
M3_rs_kh28 c2    ..............................................................................................................
M3_rs_kh29       ..............................................................................................................
M3_rs_kh31 c1    ....................................................................................T................C.......
M3_rs_kh31 c2    ..............................................................................................................
M3_rs_kh31 c3    ..............................................................................................................
M3_rs_kh31_1 c1  ..............................................................................................................
M3_rs_kh31_2 c2  ..............................................................................................................
M4_rs_kh32 c1    ..............................................................................................................
M4_rs_kh32 c2    ..............................................................................................................
M5_rs_ot1        ..............................................................................................................
M6_rs_is2 c1     ..............................................................................................................
M6_rs_is2 c2     .......................................................................................................G......
M7_cn_hj0 c1     ..............................................................................................................
M7_cn_hj0 c2     ..............................................................................................................
M8_cn_hj3_1 c1   ..............................................................................................................
M8_cn_hj3_1 c2   ..............................................................................................................
M8_cn_hj2        ..............................................................................................................
M8_cn_hj4        ..............................................................................................................
M8_cn_hj5 c1     ..............................................................................................................
M8_cn_hj5 c2     ..............................................................................................................
M9_cn_hj5        ..............................................................................................................
M13_kr_od c1     ..............................................................................................................
M13_kr_od c2     ..............................................................................................................
M13_kr_od c3     ..............................................................................................................
M14_kr_jm1 c1    ..............................................................................................................
M14_kr_jm1 c2    ..............................................................................................................
M16_kr_dr1 c1    ..............................................................................................................
M16_kr_dr1 c2    ..............................................................................................................
M18_kr_hg1 c1    ..............................................................................................................
M18_kr_hg1 c2    ..............................................................................................................
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Appendix 1. (Continued).

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                                                                                                                             550
A1_kr_gr1 c1   AATCAGACCCCGTGGCCGCGAAATGCCGCGACGATTGGTGGTGTACGTGGCAGCCTCGTGCCGCCTAACATCGCGTCGCGCCTTCCGTGGCCCTCTGGAGTAAAAAGGAC
M20_kr_nh1 c1  ..............................................................................................................
M20_kr_nh1 c2  ..............................................................................................................
M20_kr_nh1 c3  ..............................................................................................................
M20_kr_nh1 c4  ..............................................................................................................
M21_kr_gu1 c1  ..............................................................................................................
M21_kr_gu1 c2  ..............................................................................................................
M21_kr_gu1 c3  ..............................................................................................................
M21_kr_gu1 c4  ..............................................................................................................
M22_kr_mp1 c1  ..............................................................................................................
M22_kr_mp1 c2  ..............................................................................................................
M25_kr_os2 c1  ..............................................................................................................
M25_kr_os2 c2  ..............................................................................................................
M25_kr_os3     ..............................................................................................................
M25_kr_os4 c1  ..............................................................................................................
M25_kr_os4 c2  ..............................................................................................................
M28_kr_bs1     ..............................................................................................................
M28_kr_bs2 c1  ..............................................................................................................
M28_kr_bs2 c2  ..............................................................................................................
M28_kr_bs2 c3  ..............................................................................................................
M30_kr_bl2 c1  ..............................................................................................................
M30_kr_bl2 c2  ..............................................................................................................
M32_kr_mt1 c1  ..............................................................................................................
M32_kr_mt1 c2  ..............................................................................................................
M33_kr_md2 c1  ..............................................................................................................
M33_kr_md2 c2  ..............................................................................................................
M34_kr_dn1 c1  ..............................................................................................................
M34_kr_dn1 c2  ..............................................................................................................
M34_kr_dn2 c1  ..............................................................................................................
M34_kr_dn2 c2  ..............................................................................................................
M35_kr_sm1 c1  ..............................................................................................................
M35_kr_sm1 c2  ..............................................................................................................
M35_kr_sm2 c1  ..............................................................................................................
M35_kr_sm2 c2  ..............................................................................................................
P1_rs_ms1 c1   ..............................................................................................................
P1_rs_ms1 c2   ..............................................................................................................
P1_rs_ms3 c1   ..............................................................................................................
P1_rs_ms3 c2   ..............................................................................................................
P1_rs_ms3 c3   .................................................................G............................................
P1_rs_ms3 c4   ....................................................................................T.........................
P1_rs_ms3 c5   .................................................................G............................................
P2_rs_nk2      ..............................................................................................................
P3_rs_pr1      ..............................................................................................................
P4_rs_pr2 c1   ..............................................................................................................
P4_rs_pr2 c2   ..........................................................A...................................................
P4_rs_pr2 c3   ..............................................................................................................
P4_rs_pr3 c4   ..............................................................................................................
P4_rs_pr3 c5   ..............................................................................................................
P5_rs_rc1 c1   ..............................................................................................................
P5_rs_rc1 c2   ....................................................................................T.........................
P5_rs_rc1 c3   ..........................................................A...................................................
P5_rs_rc1 c4   ..............................................................................................................
P5_rs_rc1 c5   ..............................................................................................................
P6_rs_rc7      ..............................................................................................................
P7_rs_us1      ..............................................................................................................
P7_rs_us2 c1   ..............................................................................................................
P7_rs_us2 c2   .................................................................G............................................
P7_rs_us2 c3   .................................................................G............................................
P7_rs_us2 c4   ..............................................................................................................
P7_rs_us2 c5   ..............................................................................................................
P9_rs_pr5      ..............................................................................................................
P10_cn_jl1 c1  ..............................................................................................................
P10_cn_jl1 c2  ....................................................................................T.........................
P11_cn_jl3 c1  ..............................................................................................................
P11_cn_jl3 c2  ..............................................................................................................
P11_cn_jl4 c1  ..............................................................................................................
P11_cn_jl4 c2  ..............................................................................................................
P12_cn_sn2 c1  ..........................................................G...................................................
P12_cn_sn2 c2  ..............................................................................................................
P12_cn_sn2 c3  ..............................................................................................................
```

Appendix 1. (Continued).

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                                                                                                                           550
A1_kr_gr1 c1    AATCAGACCCCGTGGCCGCGAAATGCCGCGACGATTGGTGGTGTACGTGGCAGCCTCGTGCCGCCTAACATCGCGTCGCGCCTTCCGTGGCCCTCTGGAGTAAAAAGGAC
P12_cn_sn2 c4   ....................................................................................T.........................
P13_cn_mc1 c1   ..............................................................................................................
P13_cn_mc1 c2   ...................................................G..........................................................
P13_cn_mc1 c3   ..............................................................................................................
P13_cn_mc2 c1   ..............................................................................................................
P13_cn_mc2 c2   ..............................................................................................................
P13_cn_mc2 c3   ...................................................G..........................................................
P13_cn_mc2 c4   ..............................................................................................................
P14_kr_hw1 c1   ..............................................................................................................
P14_kr_hw1 c2   ..............................................................................................................
P14_kr_hw1 c3   ................T.............................................................................................
P15_kr_dm1 c1   ..............................................................................................................
P15_kr_dm1 c2   ................T.............................................................................................
P15_kr_dm1 c3   ..............................................................................................................
P16_kr_sk2 c1   ................T.............................................................................................
P16_kr_sk2 c2   ..............................................................................................................
P16_kr_sk2 c3   ..............................................................................................................
P16_kr_sk5 c1   ..............................................................................................................
P16_kr_sk5 c2   ................T.............................................................................................
P17_kr_sh1 c1   ..............................................................................................................
P17_kr_sh1 c2   ..............................................................................................................
P17_kr_sh1 c3   ..............................................................................................................
P17_kr_sh1 c4   ..............................................................................................................
P17_kr_sh1 c5   ..............................................................................................................
P17_kr_sh1 c6   ..............................................................................................................
P19_kr_gw1 c1   ..............................................................................................................
P19_kr_gw1 c2   ..............................................................................................................
P19_kr_gw1 c3   ................T.............................................................................................
P19_kr_gw1 c4   ..............................................................................................................
P19_kr_gw3 c1   ..............................................................................................................
P19_kr_gw3 c2   ..............................................................................................................
P19_kr_gw3 c3   ................T.............................................................................................
P20_kr_ck1 c1   ..............................................................................................................
P20_kr_ck1 c2   ..............................................................................................................
P20_kr_ck1 c3   ................T.............................................................................................
P20_kr_ck1 c4   ..............................................................................................................
P20_kr_ck1 c5   ..............................................................................................................
P21_kr_hc1 c1   ..............................................................................................................
P24_kr_mh2 c1   ..............................................................................................................
P24_kr_mh2 c2   ..............................................................................................................
P24_kr_mh2 c3   ..............................................................................................................
P24_kr_mh2 c4   ..............................................................................................................
P21_kr_hc1 c1   ..............................................................................................................
P21_kr_hc1 c2   ..............................................................................................................
P21_kr_hc1 c3   ..............................................................................................................
P21_kr_hc1 c4   ..............................................................................................................
P25_kr_tb1 c1   ..............................................................................................................
P25_kr_tb1 c2   ..............................................................................................................
P25_kr_tb1 c3   ..............................................................................................................
P25_kr_tb1 c4   ................T.............................................................................................
P25_kr_tb1 c5   ..............................................................................................................
P27_kr_so1 c1   ..............................................................................................................
P27_kr_so1 c2   ..............................................................................................................
P27_kr_so1 c3   ..............................................................................................................
P28_kr_il1 c1   ..............................................................................................................
P28_kr_il1 c2   ..............................................................................................................
P28_kr_il1 c3   ..............................................................................................................
P28_kr_il1 c4   ..............................................................................................................
P28_kr_il1 c5   ..............................................................................................................
P29_kr_mj1 c1   ..............................................................................................................
P29_kr_mj1 c2   ..............................................................................................................
P29_kr_mj1 c3   ..............................................................................................................
P29_kr_mj2      ..............................................................................................................
P30_kr_dk1 c1   ..............................................................................................................
P30_kr_dk1 c2   ..............................................................................................................
P30_kr_dk1 c3   ..............................................................................................................
P30_kr_dk1 c4   ..............................................................................................................
P31_kr_jr1 c1   ..............................................................................................................
P31_kr_jr1 c2   ..............................................................................................................
```

Appendix 1. (Continued).

```
                                                                                                                            550
A1_kr_gr1 c1     AATCAGACCCCGTGGCCGCGAAATGCCGCGACGATTGGTGGTGTACGTGGCAGCCTCGTGCCGCCTAACATCGCGTCGCGCCTTCCGTGGCCCTCTGGAGTAAAAAGGAC
P31_kr_jr1 c3    ..............................................................................................................
O1_jp_rb1 c1     ..............................................................................................................
O1_jp_rb1 c2     .................................................................G............................................
O1_jp_rb1 c3     ..............................................................................................................
O1_jp_rb1 c4     ..............................................................................................................
O1_jp_rb1 c5     ..............................................................................................................
O1_jp_rb1 c6     .................................................................G............................................
O2_jp_hk2 c1     .................................................................G............................................
O2_jp_hk2 c2     ..............................................................................................................
O2_jp_hk2 c3     .................................................................G............................................
O2_jp_hk2 c4     .................................................................G............................................
J1_jp_hn2        ..............................................................................................................
B1_cn_bj1        ..............................................................................................................
B2_uk_1          ..............................................................................................................
SUF_hl_1         ....................G..........................CA..G......C.Y..T.G.........C...........C...............-M.....
SUF_hl_2         ....................G..........................CA..G......C.Y..T.G.........C...........C...............-M.....
AMP_cn1          ..........................................--..T.A..G...........T.G.G............T..............G.......-......
```

Appendix 1. (Continued).

```
                                                       593
A1_kr_gr1 c1   CCTCGAGAGCCCTCCGCTGGTGCGGAGGGGCCTCTCAACCGTT
A1_kr_gr1 c2   ...........................................
A2_kr_hl3 c1   ...........................................
A2_kr_hl3 c2   ...........................................
A2_kr_hl5 c1   ...........................................
A2_kr_hl5 c2   ...........................................
A3_kr_hl5 c1   ...........................................
A3_kr_hl5 c2   ...........................................
A4_kr_hl9 c1   ...........................................
A4_kr_hl9 c2   ...........................................
A5_kr_hl10 c1  ...........................................
A5_kr_hl10 c2  ...........................................
A5_kr_hl10 c3  ...........................................
A5_kr_hl10 c4  ...........................................
A5_kr_hl10 c5  ...........................................
A5_kr_hl10 c6  ...........................................
A5_kr_hl11 c1  ...........................................
A5_kr_hl11 c2  ...........................................
A7_mn_1        ...........................................
A8_mn_2 c1     ...........................................
A8_mn_2 c2     ...........................................
M2_rs_kh1 c1   ...........................................
M2_rs_kh1 c2   ...........................................
M2_rs_kh3 c1   ...........................................
M2_rs_kh3 c2   ...........................................
M2_rs_kh3 c3   ...........................................
M2_rs_kh3 c4   ...........................................
M3_rs_kh6 c1   ...........................................
M3_rs_kh6 c2   ...........................................
M3_rs_kh8 c1   ...........................................
M3_rs_kh8 c2   ...........................................
M3_rs_kh20 c1  ...........................................
M3_rs_kh20 c2  ...........................................
M3_rs_kh22 c1  ...........................................
M3_rs_kh23 c1  ...........................................
M3_rs_kh23 c2  ...........................................
M3_rs_kh24     ...........................................
M3_rs_kh25 c1  ...........................................
M3_rs_kh25 c2  ...........................................
M3_rs_kh28 c1  ...........................................
M3_rs_kh28 c2  ...........................................
M3_rs_kh29     ...........................................
M3_rs_kh31 c1  ...........................................
M3_rs_kh31 c2  ...........................................
M3_rs_kh31 c3  ...........................................
M3_rs_kh31_1 c1...........................................
M3_rs_kh31_2 c2...........................................
M4_rs_kh32 c1  ...........................................
M4_rs_kh32 c2  ...........................................
M5_rs_ot1      ...........................................
M6_rs_is2 c1   ...........................................
M6_rs_is2 c2   ...........................................
M7_cn_hj0 c1   ...........................................
M7_cn_hj0 c2   ...........................................
M8_cn_hj3_1 c1 ...........................................
M8_cn_hj3_1 c2 ...........................................
M8_cn_hj2      ...........................................
M8_cn_hj4      ...........................................
M8_cn_hj5 c1   ...........................................
M8_cn_hj5 c2   ...........................................
M9_cn_hj5      ...........................................
M13_kr_od c1   ...........................................
M13_kr_od c2   ...........................................
M13_kr_od c3   ...........................................
M14_kr_jm1 c1  ...........................................
M14_kr_jm1 c2  ...........................................
M16_kr_dr1 c1  ...........................................
M16_kr_dr1 c2  ...........................................
M18_kr_hg1 c1  ...........................................
M18_kr_hg1 c2  ...........................................
```

Appendix 1. (Continued).

```
                                                        593
A1_kr_gr1 c1   CCTCGAGAGCCCTCCGCTGGTGCGGAGGGGCCTCTCAACCGTT
M20_kr_nh1 c1  ...........................................
M20_kr_nh1 c2  ...........................................
M20_kr_nh1 c3  ...........................................
M20_kr_nh1 c4  ...........................................
M21_kr_gu1 c1  ...........................................
M21_kr_gu1 c2  ...........................................
M21_kr_gu1 c3  ...........................................
M21_kr_gu1 c4  ...........................................
M22_kr_mp1 c1  ...........................................
M22_kr_mp1 c2  ...........................................
M25_kr_os2 c1  ...........................................
M25_kr_os2 c2  ...........................................
M25_kr_os3     ...........................................
M25_kr_os4 c1  ...........................................
M25_kr_os4 c2  ...........................................
M28_kr_bs1     ...........................................
M28_kr_bs2 c1  ...........................................
M28_kr_bs2 c2  ...........................................
M28_kr_bs2 c3  ...........................................
M30_kr_bl2 c1  ...........................................
M30_kr_bl2 c2  ...........................................
M32_kr_mt1 c1  ...........................................
M32_kr_mt1 c2  ...........................................
M33_kr_md2 c1  ...........................................
M33_kr_md2 c2  ...........................................
M34_kr_dn1 c1  ...........................................
M34_kr_dn1 c2  ...........................................
M34_kr_dn2 c1  ...........................................
M34_kr_dn2 c2  ...........................................
M35_kr_sm1 c1  ...........................................
M35_kr_sm1 c2  ...........................................
M35_kr_sm2 c1  ...........................................
M35_kr_sm2 c2  ...........................................
P1_rs_ms1 c1   ...........................................
P1_rs_ms1 c2   ...........................................
P1_rs_ms3 c1   ...........................................
P1_rs_ms3 c2   ...........................................
P1_rs_ms3 c3   ...........................................
P1_rs_ms3 c4   ...........................................
P1_rs_ms3 c5   ...........................................
P2_rs_nk2      ...........................................
P3_rs_pr1      ...........................................
P4_rs_pr2 c1   ...........................................
P4_rs_pr2 c2   ...........................................
P4_rs_pr2 c3   ...........................................
P4_rs_pr3 c1   ...........................................
P4_rs_pr3 c2   ...........................................
P5_rs_rc1 c1   ...........................................
P5_rs_rc1 c2   ...........................................
P5_rs_rc1 c3   ...........................................
P5_rs_rc1 c4   ...........................................
P5_rs_rc1 c5   ...........................................
P6_rs_rc7      ...........................................
P7_rs_us1      ...........................................
P7_rs_us2 c1   ...........................................
P7_rs_us2 c2   ...........................................
P7_rs_us2 c3   ...........................................
P7_rs_us2 c4   ...........................................
P7_rs_us2 c5   ...........................................
P9_rs_pr5      ...........................................
P10_cn_jl1 c1  ...........................................
P10_cn_jl1 c2  ...........................................
P11_cn_jl3 c1  ...........................................
P11_cn_jl3 c2  ...........................................
P11_cn_jl4 c1  ...........................................
P11_cn_jl4 c2  ...........................................
P12_cn_sn2 c1  ...........................................
P12_cn_sn2 c2  ...........................................
P12_cn_sn2 c1  ...........................................
```

Appendix 1. (Continued).

```
                                                       593
A1_kr_gr1 c1   CCTCGAGAGCCCTCCGCTGGTGCGGAGGGGCCTCTCAACCGTT
P12_cn_sn2 c2  ...........................................
P13_cn_mc1 c1  ...........................................
P13_cn_mc1 c2  ...........................................
P13_cn_mc1 c3  ...........................................
P13_cn_mc2 c1  ...........................................
P13_cn_mc2 c2  ...........................................
P13_cn_mc2 c3  ...........................................
P13_cn_mc2 c4  ...........................................
P14_kr_hw1 c1  ...........................................
P14_kr_hw1 c2  ...........................................
P14_kr_hw1 c3  ...........................................
P15_kr_dm1 c1  ...........................................
P15_kr_dm1 c2  ...........................................
P15_kr_dm1 c3  ...........................................
P16_kr_sk2 c1  ...........................................
P16_kr_sk2 c2  ...........................................
P16_kr_sk2 c3  ...........................................
P16_kr_sk5 c1  ...........................................
P16_kr_sk5 c2  ...........................................
P17_kr_sh1 c1  ...........................................
P17_kr_sh1 c2  ...........................................
P17_kr_sh1 c3  ...........................................
P17_kr_sh1 c4  ...........................................
P17_kr_sh1 c5  ...........................................
P17_kr_sh1 c6  ...........................................
P19_kr_gw3 c1  ...........................................
P19_kr_gw3 c2  ...........................................
P19_kr_gw3 c3  ...........................................
P19_kr_gw1 c1  ...........................................
P19_kr_gw1 c2  ...........................................
P19_kr_gw1 c3  ...........................................
P19_kr_gw1 c4  ...........................................
P20_kr_ck1 c1  ...........................................
P20_kr_ck1 c2  ...........................................
P20_kr_ck1 c3  ...........................................
P20_kr_ck1 c4  ...........................................
P20_kr_ck1 c5  ...........................................
P21_kr_hc1     ...........................................
P24_kr_mh2 c1  ...........................................
P24_kr_mh2 c2  ...........................................
P24_kr_mh2 c3  ...........................................
P24_kr_mh2 c4  ...........................................
P21_kr_hc1 c1  ...........................................
P21_kr_hc1 c2  ...........................................
P21_kr_hc1 c3  ...........................................
P21_kr_hc1 c4  ...........................................
P25_kr_tb1 c1  ...........................................
P25_kr_tb1 c2  ...........................................
P25_kr_tb1 c3  ...........................................
P25_kr_tb1 c4  ...........................................
P25_kr_tb1 c5  ...........................................
P27_kr_so1 c1  ...........................................
P27_kr_so1 c2  ...........................................
P27_kr_so1 c3  ...........................................
P28_kr_il1 c1  ...........................................
P28_kr_il1 c2  ...........................................
P28_kr_il1 c3  ...........................................
P28_kr_il1 c4  ...........................................
P28_kr_il1 c5  ...........................................
P29_kr_mj1 c1  ...........................................
P29_kr_mj1 c2  ...........................................
P29_kr_mj1 c3  ...........................................
P29_kr_mj2     ...........................................
P30_kr_dk1 c1  ...........................................
P30_kr_dk1 c2  ...........................................
P30_kr_dk1 c3  ...........................................
P30_kr_dk1 c4  ...........................................
P31_kr_jr1 c1  ...........................................
P31_kr_jr1 c2  ...........................................
```

Appendix 1. (Continued).

```
                                                       593
A1_kr_gr1 c1   CCTCGAGAGCCCTCCGCTGGTGCGGAGGGGCCTCTCAACCGTT
P31_kr_jr1 c3  ...........................................
O1_jp_rb1 c1   ...........................................
O1_jp_rb1 c2   ...........................................
O1_jp_rb1 c3   ...........................................
O1_jp_rb1 c4   ...........................................
O1_jp_rb1 c5   ...........................................
O1_jp_rb1 c6   ...........................................
O2_jp_hk2 c1   ...........................................
O2_jp_hk2 c2   ...........................................
O2_jp_hk2 c3   ...........................................
O2_jp_hk2 c4   ...........................................
J1_jp_hn2      ...........................................
B1_cn_bj1      ...........................................
B2_uk_1        ...........................................
SUF_hl_1       ............C....C.........................
SUF_hl_2       ............C....C.........................
AMP_cn1        ........A...C.....A........................
```

Appendix 2.

Aligned sequences of combined cpDNA *trnK* (1–677 bp), *matK* (678–1810 bp) and *ndhF* (1811–3803 bp) regions from taxa of the *B. manshuriensis* complex and related taxa. See Table 4 for acronyms. Dashes (-) indicate gaps and dots (.) indicate matched sequences to the first taxon.

```
                                                                                                                                 120
A1_kr_gr1      AGACTATCAGTAGAGTTTGTAAGACCACGACTGATCCTGAAAGGAATGAATGGAAAAAAGAGCATGTCGTATCAACGTAGAATTATTTTCAACTTTCGTTCTTATTAGATCAGTAAAAAA
A1_kr_gr2      ........................................................................................................................
A2_kr_hl1      ........................................................................................................................
A2_kr_hl2      ........................................................................................................................
A2_kr_hl3      ........................................................................................................................
A2_kr_hl4      ........................................................................................................................
A3_kr_hl5      ........................................................................................................................
A3_kr_hl6      ........................................................................................................................
A3_kr_hl7      ........................................................................................................................
A3_kr_hl8      ........................................................................................................................
A4_kr_hl9      ........................................................................................................................
A5_kr_hl10     ........................................................................................................................
A5_kr_hl11     ........................................................................................................................
A5_kr_hl12     ........................................................................................................................
A5_kr_hl13     ........................................................................................................................
A5_kr_hl14     ........................................................................................................................
A7_mn_1        ........................................................................................................................
A8_mn_2        ........................................................................................................................
M1_rs_kb1      ........................................................................................................................
M2_rs_kh1      ........................................................................................................................
M2_rs_kh2      ........................................................................................................................
M2_rs_kh3      ........................................................................................................................
M3_rs_kh4      ........................................................................................................................
M3_rs_kh5      ........................................................................................................................
M3_rs_kh6      ........................................................................................................................
M3_rs_kh7      ........................................................................................................................
M3_rs_kh8      ........................................................................................................................
M3_rs_kh9      ........................................................................................................................
M3_rs_kh10     ........................................................................................................................
M3_rs_kh11     ........................................................................................................................
M3_rs_kh12     ........................................................................................................................
M3_rs_kh13     ........................................................................................................................
M3_rs_kh14     ........................................................................................................................
M3_rs_kh15     ........................................................................................................................
M3_rs_kh16     ........................................................................................................................
M3_rs_kh17     ........................................................................................................................
M3_rs_kh18     ........................................................................................................................
M3_rs_kh19     ........................................................................................................................
M3_rs_kh20     ........................................................................................................................
M3_rs_kh21     ........................................................................................................................
M3_rs_kh22     ........................................................................................................................
M3_rs_kh23     ........................................................................................................................
M3_rs_kh24     ........................................................................................................................
M3_rs_kh25     ........................................................................................................................
M3_rs_kh26     ........................................................................................................................
M3_rs_kh27     ........................................................................................................................
M3_rs_kh28     ........................................................................................................................
M3_rs_kh29     ........................................................................................................................
M3_rs_kh30     ........................................................................................................................
M3_rs_kh31     ........................................................................................................................
M4_rs_kh32     ........................................................................................................................
M5_rs_ot1      ........................................................................................................................
M6_rs_ri1      ........................................................................................................................
M6_rs_ri2      ........................................................................................................................
M7_cn_hj1      ........................................................................................................................
M8_cn_hj2      ........................................................................................................................
M8_cn_hj3      ........................................................................................................................
M8_cn_hj4      ........................................................................................................................
M9_cn_hj5      ........................................................................................................................
M10_cn_nm1     ........................................................................................................................
M11_cn_ul1     ........................................................................................................................
M12_cn_sb1     ........................................................................................................................
M12_cn_sb2     ........................................................................................................................
M13_kr_od1     ........................................................................................................................
M14_kr_jm1     ........................................................................................................................
M14_kr_jm2     ........................................................................................................................
M14_kr_jm3     ........................................................................................................................
M15_kr_dg1     ........................................................................................................................
M16_kr_dr1     ........................................................................................................................
M17_kr_sw1     ........................................................................................................................
M17_kr_sw2     ........................................................................................................................
M18_kr_hg1     ........................................................................................................................
M19_kr_gy1     ........................................................................................................................
M20_kr_nh1     ........................................................................................................................
M20_kr_nh2     ........................................................................................................................
M21_kr_gu1     ........................................................................................................................
M22_kr_mp1     ........................................................................................................................
M23_kr_bc1     ........................................................................................................................
M24_kr_os1     ........................................................................................................................
M25_kr_os2     ........................................................................................................................
M25_kr_os3     ........................................................................................................................
M25_kr_os4     ........................................................................................................................
M25_kr_os5     ........................................................................................................................
M26_kr_sn1     ........................................................................................................................
M27_kr_gn1     ........................................................................................................................
M27_kr_gn2     ........................................................................................................................
```

Appendix 2. (Continued).

```
                                                                                                                                     120
A1_kr_gr1      AGACTATCAGTAGAGTTTGTAAGACCACGACTGATCCTGAAAGGAATGAATGGAAAAAAGAGCATGTCGTATCAACGTAGAATTATTTTCAACTTTCGTTCTTATTAGATCAGTAAAAAA
M28_kr_bs1     ........................................................................................................................
M28_kr_bs2     ........................................................................................................................
M28_kr_bs3     ........................................................................................................................
M29_kr_jn1     ........................................................................................................................
M30_kr_bl1     ........................................................................................................................
M30_kr_bl2     ........................................................................................................................
M31_kr_jl1     ........................................................................................................................
M31_kr_jl2     ........................................................................................................................
M32_kr_mt1     ........................................................................................................................
M33_kr_md1     ........................................................................................................................
M33_kr_md2     ........................................................................................................................
M34_kr_dn1     ........................................................................................................................
M34_kr_dn2     ........................................................................................................................
M35_kr_sm1     ........................................................................................................................
M35_kr_sm2     ........................................................................................................................
P1_rs_ms1      ........................................................................................................................
P1_rs_ms2      ........................................................................................................................
P1_rs_ms3      ........................................................................................................................
P1_rs_ms4      ........................................................................................................................
P2_rs_nk1      ........................................................................................................................
P2_rs_nk2      ........................................................................................................................
P3_rs_pr1      ........................................................................................................................
P4_rs_pr2      ........................................................................................................................
P4_rs_pr3      ........................................................................................................................
P5_rs_rc1      ........................................................................................................................
P5_rs_rc2      ........................................................................................................................
P5_rs_rc3      ........................................................................................................................
P6_rs_rc4      ........................................................................................................................
P6_rs_rc5      ........................................................................................................................
P6_rs_rc6      ........................................................................................................................
P6_rs_rc7      ........................................................................................................................
P6_rs_rc8      ........................................................................................................................
P7_rs_us1      ........................................................................................................................
P7_rs_us2      ........................................................................................................................
P8_rs_pr4      ........................................................................................................................
P9_rs_pr5      ........................................................................................................................
P10_cn_jl1     ........................................................................................................................
P10_cn_jl2     ........................................................................................................................
P11_cn_jl3     ........................................................................................................................
P11_cn_jl4     ........................................................................................................................
P12_cn_sn1     ........................................................................................................................
P12_cn_sn2     ........................................................................................................................
P13_cn_mc1     ........................................................................................................................
P13_cn_mc2     ........................................................................................................................
P14_kr_hw1     ........................................................................................................................
P14_kr_hw2     ........................................................................................................................
P15_kr_dm1     ........................................................................................................................
P15_kr_dm2     ........................................................................................................................
P15_kr_dm3     ........................................................................................................................
P16_kr_sk1     ........................................................................................................................
P16_kr_sk2     ........................................................................................................................
P16_kr_sk3     ........................................................................................................................
P16_kr_sk4     ........................................................................................................................
P16_kr_sk5     ........................................................................................................................
P16_kr_sk6     ........................................................................................................................
P16_kr_sk7     ........................................................................................................................
P16_kr_sk8     ........................................................................................................................
P17_kr_sh1     ........................................................................................................................
P18_kr_gb1     ........................................................................................................................
P19_kr_gw1     ........................................................................................................................
P19_kr_gw2     ........................................................................................................................
P19_kr_gw3     ........................................................................................................................
P20_kr_ck1     ........................................................................................................................
P20_kr_ck2     ........................................................................................................................
P21_kr_hc1     ........................................................................................................................
P22_kr_hb1     ........................................................................................................................
P23_kr_hb2     ........................................................................................................................
P24_kr_mh1     ........................................................................................................................
P24_kr_mh2     ........................................................................................................................
P25_kr_tb1     ........................................................................................................................
P25_kr_tb2     ........................................................................................................................
P26_kr_tb3     ........................................................................................................................
P27_kr_so1     ........................................................................................................................
P27_kr_so2     ........................................................................................................................
P27_kr_so3     ........................................................................................................................
P27_kr_so4     ........................................................................................................................
P27_kr_so5     ........................................................................................................................
P27_kr_so6     ........................................................................................................................
P28_kr_il1     .......................................................................................................................
P29_kr_mj1     ........................................................................................................................
P29_kr_mj2     ........................................................................................................................
P30_kr_dk1     ........................................................................................................................
P31_kr_jr1     ........................................................................................................................
P32_kr_jr2     ........................................................................................................................
O1_jp_rb1      ........................................................................................................................
O2_jp_hk1      ........................................................................................................................
O2_jp_hk2      ........................................................................................................................
O2_jp_hk3      ........................................................................................................................
O2_jp_hk4      ........................................................................................................................
J1_jp_hn1      ........................................................................................................................
J1_jp_hn2      ........................................................................................................................
J2_jp_ky1      ........................................................................................................................
J3_jp_jp1      ........................................................................................................................
B1_cn_bj1      ........................................................................................................................
B2_uk_1        ........................................................................................................................
AMP_cn_1       ...........................................................................-------...................T..................
SUF_kr_hl1     ........................................................................................................................
SUF_kr_hl2     ........................................................................................................................
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Appendix 2. (Continued).

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                                                                                                                                          240
A1_kr_gr1       CTTGGATTAAATTTTTAGAACGAAATGAGTTCAAAATTGGGTCGATTGAATACATGGATCGAGCCTTATGGCTCTAATTGTAGGGAAAGAAAAAGCAACGAGCTTATGTTCTTCGTTGGA
A1_kr_gr2       ........C...............................................................................................................
A2_kr_hl1       ........................................................................................................................
A2_kr_hl2       ........................................................................................................................
A2_kr_hl3       ........................................................................................................................
A2_kr_hl4       ........................................................................................................................
A3_kr_hl5       ........................................................................................................................
A3_kr_hl6       ........................................................................................................................
A3_kr_hl7       ........................................................................................................................
A3_kr_hl8       ........................................................................................................................
A4_kr_hl9       ........................................................................................................................
A5_kr_hl10      ........C...............................................................................................................
A5_kr_hl11      ........C...............................................................................................................
A5_kr_hl12      ........................................................................................................................
A5_kr_hl13      ........C...............................................................................................................
A5_kr_hl14      ........C...............................................................................................................
A7_mn_1         ........C...............................................................................................................
A8_mn_2         ........C...............................................................................................................
M1_rs_kb1       ........C...............................................................................................................
M2_rs_kh1       ........C...............................................................................................................
M2_rs_kh2       ........C...............................................................................................................
M2_rs_kh3       ........C...............................................................................................................
M3_rs_kh4       ........C...............................................................................................................
M3_rs_kh5       ........C...............................................................................................................
M3_rs_kh6       .........C..............................................................................................................
M3_rs_kh7       .........C..............................................................................................................
M3_rs_kh8       ........C...............................................................................................................
M3_rs_kh9       .........C..............................................................................................................
M3_rs_kh10      .........C..............................................................................................................
M3_rs_kh11      .........C..............................................................................................................
M3_rs_kh12      .........C..............................................................................................................
M3_rs_kh13      .........C..............................................................................................................
M3_rs_kh14      .........C..............................................................................................................
M3_rs_kh15      ........C...............................................................................................................
M3_rs_kh16      ........C...............................................................................................................
M3_rs_kh17      ........C...............................................................................................................
M3_rs_kh18      .........C..............................................................................................................
M3_rs_kh19      ........C...............................................................................................................
M3_rs_kh20      .........C..............................................................................................................
M3_rs_kh21      ........C...............................................................................................................
M3_rs_kh22      ........C...............................................................................................................
M3_rs_kh23      .........C..............................................................................................................
M3_rs_kh24      ........C...............................................................................................................
M3_rs_kh25      ........C...............................................................................................................
M3_rs_kh26      .........C..............................................................................................................
M3_rs_kh27      ........C...............................................................................................................
M3_rs_kh28      ........C...............................................................................................................
M3_rs_kh29      ........C...............................................................................................................
M3_rs_kh30      .........C..............................................................................................................
M3_rs_kh31      ........C...............................................................................................................
M4_rs_kh32      ........C...............................................................................................................
M5_rs_ot1       .........C..............................................................................................................
M6_rs_ri1       .........C..............................................................................................................
M6_rs_ri2       ........C...............................................................................................................
M7_cn_hj1       ........................................................................................................................
M8_cn_hj2       ........C...............................................................................................................
M8_cn_hj3       ........C...............................................................................................................
M8_cn_hj4       ........C...............................................................................................................
M9_cn_hj5       ........C....................C..........................................................................................
M10_cn_nm1      ........C...............................................................................................................
M11_cn_ul1      ........C...............................................................................................................
M12_cn_sb1      ........C...............................................................................................................
M12_cn_sb2      ........C...............................................................................................................
M13_kr_od1      ........C...............................................................................................................
M14_kr_jm1      .........C..............................................................................................................
M14_kr_jm2      .........C..............................................................................................................
M14_kr_jm3      .........C..............................................................................................................
M15_kr_dg1      ........................................................................................................................
M16_kr_dr1      ........C...............................................................................................................
M17_kr_sw1      ........................................................................................................................
M17_kr_sw2      ........................................................................................................................
M18_kr_hg1      ........C...............................................................................................................
M19_kr_gy1      ........C...............................................................................................................
M20_kr_nh1      ........CC..............................................................................................................
M20_kr_nh2      ........CC..............................................................................................................
M21_kr_gu1      ........C...............................................................................................................
M22_kr_mp1      ........C...............................................................................................................
M23_kr_bc1      ........C...............................................................................................................
M24_kr_os1      ........C...............................................................................................................
M25_kr_os2      ........C...............................................................................................................
M25_kr_os3      .........C..............................................................................................................
M25_kr_os4      ........C...............................................................................................................
M25_kr_os5      ........C...............................................................................................................
M26_kr_sn1      ........C...............................................................................................................
M27_kr_gn1      ........C...............................................................................................................
M27_kr_gn2      ........C...............................................................................................................
M28_kr_bs1      .........C..............................................................................................................
M28_kr_bs2      ........C...............................................................................................................
M28_kr_bs3      .........C..............................................................................................................
M29_kr_jn1      ........C...............................................................................................................
M30_kr_bl1      ........C...............................................................................................................
M30_kr_bl2      .........C..............................................................................................................
M31_kr_jl1      .........C..............................................................................................................
M31_kr_jl2      ........C...............................................................................................................
M32_kr_mt1      ........C...............................................................................................................
M33_kr_md1      ........C...............................................................................................................
M33_kr_md2      ........C...............................................................................................................
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Appendix 2. (Continued).

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                                                                                                                                     240
A1_kr_gr1      CTTGGATTAAATTTTTAGAACGAAATGAGTTCAAAATTGGGTCGATTGAATACATGGATCGAGCCTTATGGCTCTAATTGTAGGGAAAGAAAAAGCAACGAGCTTATGTTCTTCGTTGGA
M34_kr_dn1     ........C...............................................................................................................
M34_kr_dn2     ........C...............................................................................................................
M35_kr_sm1     ........C...............................................................................................................
M35_kr_sm2     ........C...............................................................................................................
P1_rs_ms1      ........C...............................................................................................................
P1_rs_ms2      ........C...............................................................................................................
P1_rs_ms3      ........C...............................................................................................................
P1_rs_ms4      ........C...............................................................................................................
P2_rs_nk1      ........C...............................................................................................................
P2_rs_nk2      ........C...............................................................................................................
P3_rs_pr1      ........C...............................................................................................................
P4_rs_pr2      ........C...............................................................................................................
P4_rs_pr3      .........C..............................................................................................................
P5_rs_rc1      .........C..............................................................................................................
P5_rs_rc2      ........C...............................................................................................................
P5_rs_rc3      ........C...............................................................................................................
P6_rs_rc4      .........C..............................................................................................................
P6_rs_rc5      .........C..............................................................................................................
P6_rs_rc6      .........C..............................................................................................................
P6_rs_rc7      .........C..............................................................................................................
P6_rs_rc8      ........C...............................................................................................................
P7_rs_us1      ........C...............................................................................................................
P7_rs_us2      ........C...............................................................................................................
P8_rs_pr4      ........C...............................................................................................................
P9_rs_pr5      .........C..............................................................................................................
P10_cn_jl1     ........C...............................................................................................................
P10_cn_jl2     ........C...............................................................................................................
P11_cn_jl3     ........C...............................................................................................................
P11_cn_jl4     ........C...............................................................................................................
P12_cn_sn1     ........C...............................................................................................................
P12_cn_sn2     ........C...............................................................................................................
P13_cn_mc1     ........C...............................................................................................................
P13_cn_mc2     ........C...............................................................................................................
P14_kr_hw1     ........C...............................................................................................................
P14_kr_hw2     ........C...............................................................................................................
P15_kr_dm1     ........................................................................................................................
P15_kr_dm2     ........................................................................................................................
P15_kr_dm3     ........................................................................................................................
P16_kr_sk1     ........C...............................................................................................................
P16_kr_sk2     ........C...............................................................................................................
P16_kr_sk3     ........C...............................................................................................................
P16_kr_sk4     ........C...............................................................................................................
P16_kr_sk5     ........C...............................................................................................................
P16_kr_sk6     ........C...............................................................................................................
P16_kr_sk7     ........C...............................................................................................................
P16_kr_sk8     ........C...............................................................................................................
P17_kr_sh1     ........................................................................................................................
P18_kr_gb1     ........C...............................................................................................................
P19_kr_gw1     ........C...............................................................................................................
P19_kr_gw2     ........C...............................................................................................................
P19_kr_gw3     ........C...............................................................................................................
P20_kr_ck1     ........C...............................................................................................................
P20_kr_ck2     ........C...............................................................................................................
P21_kr_hc1     ........C...............................................................................................................
P22_kr_hb1     ........C...............................................................................................................
P23_kr_hb2     ........C...............................................................................................................
P24_kr_mh1     ........C...............................................................................................................
P24_kr_mh2     ........C...............................................................................................................
p25_kr_tb1     ........C...............................................................................................................
p25_kr_tb2     ........C...............................................................................................................
P26_kr_tb3     ........C...............................................................................................................
P27_kr_so1     ........C...............................................................................................................
P27_kr_so2     ........C...............................................................................................................
P27_kr_so3     ........C...............................................................................................................
P27_kr_so4     ........C...............................................................................................................
P27_kr_so5     ........C...............................................................................................................
P27_kr_so6     ........C...............................................................................................................
P28_kr_il1     ........C...............................................................................................................
P29_kr_mj1     ........C...............................................................................................................
P29_kr_mj2     ........C...............................................................................................................
P30_kr_dk1     ........C...............................................................................................................
P31_kr_jr1     ........C...............................................................................................................
P32_kr_jr2     ........C...............................................................................................................
O1_jp_rb1      ........C...............................................................................................................
O2_jp_hk1      ........C...............................................................................................................
O2_jp_hk2      ........C...............................................................................................................
O2_jp_hk3      ........C...............................................................................................................
O2_jp_hk4      ........C...............................................................................................................
J1_jp_hn1      ........C...............................................................................................................
J1_jp_hn2      ........C...............................................................................................................
J2_jp_ky1      ........CC..............................................................................................................
J3_jp_jp1      ........C...............................................................................................................
B1_cn_bj1      ........CC..............................................................................................................
B2_uk_1        .........C..............................................................................................................
AMP_cn_1       .....G..................................................................................................................
SUF_kr_hl1     .....G...............................................G..................................................................
SUF_kr_hl2     .....G...............................................G..................................................................
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Appendix 2. (Continued).

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                                                                                                                                      360
A1_kr_gr1       ACGATCACCCGCGCTAATTAAACGTTAAAAATAGATTAGTGACTGGGGCGGGAAAGGATTTTCCAAGAGTGGATTACCGATTTTTGAGTGAATCCTAACTATATACCCATTTTTCATTAG
A1_kr_gr2       ..................G..................................................................T..................................
A2_kr_hl1       ........................................................................................................................
A2_kr_hl2       ........................................................................................................................
A2_kr_hl3       ........................................................................................................................
A2_kr_hl4       ........................................................................................................................
A3_kr_hl5       ........................................................................................................................
A3_kr_hl6       ........................................................................................................................
A3_kr_hl7       ........................................................................................................................
A3_kr_hl8       ........................................................................................................................
A4_kr_hl9       ........................................................................................................................
A5_kr_hl10      ..................G..................................................................T..................................
A5_kr_hl11      ..................G..................................................................T..................................
A5_kr_hl12      ........................................................................................................................
A5_kr_hl13      ..................G..................................................................T..................................
A5_kr_hl14      ..................G..................................................................T..................................
A7_mn_1         ..................G..................................................................T..................................
A8_mn_2         ..................G..................................................................T..................................
M1_rs_kb1       ..................G..................................................................T..................................
M2_rs_kh1       ..................G..................................................................T..................................
M2_rs_kh2       ..................G..................................................................T..................................
M2_rs_kh3       ..................G..................................................................T..................................
M3_rs_kh4       ..................G..................................................................T..................................
M3_rs_kh5       ..................G..................................................................T..................................
M3_rs_kh6       .....................................................................................T..................................
M3_rs_kh7       .....................................................................................T..................................
M3_rs_kh8       ..................G..................................................................T..................................
M3_rs_kh9       .....................................................................................T..................................
M3_rs_kh10      .....................................................................................T..................................
M3_rs_kh11      .....................................................................................T..................................
M3_rs_kh12      .....................................................................................T..................................
M3_rs_kh13      .....................................................................................T..................................
M3_rs_kh14      .....................................................................................T..................................
M3_rs_kh15      ..................G..................................................................T..................................
M3_rs_kh16      ..................G..................................................................T..................................
M3_rs_kh17      ..................G..................................................................T..................................
M3_rs_kh18      .....................................................................................T..................................
M3_rs_kh19      ..................G..................................................................T..................................
M3_rs_kh20      .....................................................................................T..................................
M3_rs_kh21      ..................G..................................................................T..................................
M3_rs_kh22      ..................G..................................................................T..................................
M3_rs_kh23      .....................................................................................T..................................
M3_rs_kh24      ..................G..................................................................T..................................
M3_rs_kh25      ..................G..................................................................T..................................
M3_rs_kh26      .....................................................................................T..................................
M3_rs_kh27      ..................G..................................................................T..................................
M3_rs_kh28      ..................G..................................................................T..................................
M3_rs_kh29      ..................G..................................................................T..................................
M3_rs_kh30      .....................................................................................T..................................
M3_rs_kh31      ..................G..................................................................T..................................
M4_rs_kh32      ..................G..................................................................T..................................
M5_rs_ot1       .....................................................................................T..................................
M6_rs_ri1       .........................................C...........................................T..................................
M6_rs_ri2       ..................G..................................................................T..................................
M7_cn_hj1       ........................................................................................................................
M8_cn_hj3       ..................G..................................................................T..................................
M8_cn_hj2       ..................G..................................................................T..................................
M8_cn_hj4       ..................G..................................................................T..................................
M9_cn_hj5       ..................G..................................................................T..................................
M10_cn_nm1      ..................G..................................................................T..................................
M11_cn_ul1      ..................G..................................................................T..................................
M12_cn_sb1      ..................G..................................................................T..................................
M12_cn_sb2      ..................G..................................................................T..................................
M13_kr_od1      ..................G..................................................................T..................................
M14_kr_jm1      .....................................................................................T..................................
M14_kr_jm2      .....................................................................................T..................................
M14_kr_jm3      .....................................................................................T..................................
M15_kr_dg1      ........................................................................................................................
M16_kr_dr1      ..................G..................................................................T..................................
M17_kr_sw1      ........................................................................................................................
M17_kr_sw2      ........................................................................................................................
M18_kr_hg1      ..................G..................................................................T..................................
M19_kr_gy1      ..................G..................................................................T..................................
M20_kr_nh1      .....................................................................................T..................................
M20_kr_nh2      .....................................................................................T..................................
M21_kr_gu1      ..................G..................................................................T..................................
M22_kr_mp1      ..................G..................................................................T..................................
M23_kr_bc1      ..................G..................................................................T..................................
M24_kr_os1      ..................G..................................................................T..................................
M25_kr_os2      ..................G..................................................................T..................................
M25_kr_os3      .........................................C...........................................T..................................
M25_kr_os4      ..................G..................................................................T..................................
M25_kr_os5      ..................G..................................................................T..................................
M26_kr_sn1      ..................G..................................................................T..................................
M27_kr_gn1      ..................G..................................................................T..................................
M27_kr_gn2      ..................G..................................................................T..................................
M28_kr_bs1      .....................................................................................T..................................
M28_kr_bs2      ..................G..................................................................T..................................
M28_kr_bs3      .....................................................................................T..................................
M29_kr_jn1      ..................G..................................................................T..................................
M30_kr_bl1      ..................G..................................................................T..................................
M30_kr_bl2      .....................................................................................T..................................
M31_kr_jl1      .....................................................................................T..................................
M31_kr_jl2      ..................G..................................................................T..................................
M32_kr_mt1      ..................G..................................................................T..................................
M33_kr_md1      ..................G..................................................................T..................................
M33_kr_md2      ..................G..................................................................T..................................
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Appendix 2. (Continued).

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                                                                                                                                     360
A1_kr_gr1      ACGATCACCCGCGCTAATTAAACGTTAAAAATAGATTAGTGACTGGGGCGGGAAAGGATTTTCCAAGAGTGGATTACCGATTTTTGAGTGAATCCTAACTATATACCCATTTTTCATTAG
M34_kr_dn1     ..................G..................................................................T..................................
M34_kr_dn2     ..................G..................................................................T..................................
M35_kr_sm1     ..................G..................................................................T..................................
M35_kr_sm2     ..................G..................................................................T..................................
P1_rs_ms1      ..................G..................................................................T..................................
P1_rs_ms2      ..................G..................................................................T..................................
P1_rs_ms3      ..................G..................................................................T..................................
P1_rs_ms4      ..................G..................................................................T..................................
P2_rs_nk1      ..................G..................................................................T..................................
P2_rs_nk2      ..................G..................................................................T..................................
P3_rs_pr1      ..................G..................................................................T..................................
P4_rs_pr2      ..................G..................................................................T..................................
P4_rs_pr3      .........................................C...........................................T..................................
P5_rs_rc1      .....................................................................................T..................................
P5_rs_rc2      ..................G..................................................................T..................................
P5_rs_rc3      ..................G..................................................................T..................................
P6_rs_rc4      ................C....................................................................T..................................
P6_rs_rc5      ................C....................................................................T..................................
P6_rs_rc6      ................C....................................................................T..................................
P6_rs_rc7      ................C....................................................................T..................................
P6_rs_rc8      ..................G..................................................................T..................................
P7_rs_us1      ..................G..................................................................T..................................
P7_rs_us2      ..................G..................................................................T..................................
P8_rs_pr4      ..................G..................................................................T..................................
P9_rs_pr5      .....................................................................................T..................................
P10_cn_jl1     ..................G..................................................................T..................................
P10_cn_jl2     ..................G..................................................................T..................................
P11_cn_jl3     ..................G..................................................................T..................................
P11_cn_jl4     ..................G..................................................................T..................................
P12_cn_sn1     ..................G..................................................................T..................................
P12_cn_sn2     ..................G..................................................................T..................................
P13_cn_mc1     ..................G..................................................................T..................................
P13_cn_mc2     ..................G..................................................................T..................................
P14_kr_hw1     ..................G..................................................................T..................................
P14_kr_hw2     ..................G..................................................................T..................................
P15_kr_dm1     ........................................................................................................................
P15_kr_dm2     ........................................................................................................................
P15_kr_dm3     ........................................................................................................................
P16_kr_sk1     ..................G..................................................................T..................................
P16_kr_sk2     ..................G..................................................................T..................................
P16_kr_sk3     ..................G..................................................................T..................................
P16_kr_sk4     ..................G..................................................................T..................................
P16_kr_sk5     ..................G..................................................................T..................................
P16_kr_sk6     ..................G..................................................................T..................................
P16_kr_sk7     ..................G..................................................................T..................................
P16_kr_sk8     ..................G..................................................................T..................................
P17_kr_sh1     ........................................................................................................................
P18_kr_gb1     ..................G..................................................................T..................................
P19_kr_gw1     ..................G..................................................................T..................................
P19_kr_gw2     ..................G..................................................................T..................................
P19_kr_gw3     ..................G..................................................................T..................................
P20_kr_ck1     ..................G..................................................................T..................................
P20_kr_ck2     ..................G..................................................................T..................................
P21_kr_hc1     ..................G..................................................................T..................................
P22_kr_hb1     ..................G..................................................................T..................................
P23_kr_hb2     ..................G..................................................................T..................................
P24_kr_mh1     ..................G..................................................................T..................................
P24_kr_mh2     ..................G..................................................................T..................................
p25_kr_tb1     ..................G..................................................................T..................................
p25_kr_tb2     ..................G..................................................................T..................................
P26_kr_tb3     ..................G..................................................................T..................................
P27_kr_so1     ..................G..................................................................T..................................
P27_kr_so2     ..................G..................................................................T..................................
P27_kr_so3     ..................G..................................................................T..................................
P27_kr_so4     ..................G..................................................................T..................................
P27_kr_so5     ..................G..................................................................T..................................
P27_kr_so6     ..................G..................................................................T..................................
P28_kr_il1     ..................G..................................................................T..................................
P29_kr_mj1     ..................G..................................................................T..................................
P29_kr_mj2     ..................G..................................................................T..................................
P30_kr_dk1     ..................G..................................................................T..................................
P31_kr_jr1     ..................G..................................................................T..................................
P32_kr_jr2     ..................G..................................................................T..................................
O1_jp_rb1      ..................G..................................................................T..................................
O2_jp_hk1      ..................G..................................................................T..................................
O2_jp_hk2      ..................G..................................................................T..................................
O2_jp_hk3      ..................G..................................................................T..................................
O2_jp_hk4      ..................G..................................................................T..................................
J1_jp_hn1      ..................G..................................................................T..................................
J1_jp_hn2      ..................G..................................................................T..................................
J2_jp_ky1      .....................................................................................T..................................
J3_jp_jp1      ..................G..................................................................T..................................
B1_cn_bj1      .....................................................................................T..................................
B2_uk_1        .....................................................................................T..................................
AMP_cn_1       .....................................................................................T..........................C.......
SUF_kr_hl1     .....................................................................................T................C.................
SUF_kr_hl2     .....................................................................................T................C.................
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Appendix 2. (Continued).

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                                                                                                                                    480
A1_kr_gr1      ATTAGAAAATGGAGATTAATGTGTAAAAGAAACAGTATATTGATAAGGATACTTTTTTT-CCAAAATCAAAAGAGCGATTGGGTTGAAAAAATAAAGGATTTCTAATCATCTTCTTAACC
A1_kr_gr2      ...........................................................-............................................................
A2_kr_hl1      ...........................................................-............................................................
A2_kr_hl2      ...........................................................-............................................................
A2_kr_hl3      ...........................................................-............................................................
A2_kr_hl4      ...........................................................-............................................................
A3_kr_hl5      ...........................................................-............................................................
A3_kr_hl6      ...........................................................-............................................................
A3_kr_hl7      ...........................................................-............................................................
A3_kr_hl8      ...........................................................-............................................................
A4_kr_hl9      ...........................................................-............................................................
A5_kr_hl10     ...........................................................-............................................................
A5_kr_hl11     ...........................................................-............................................................
A5_kr_hl12     ...........................................................-............................................................
A5_kr_hl13     ...........................................................-............................................................
A5_kr_hl14     ...........................................................-............................................................
A7_mn_1        ....T......................................................-............................................................
A8_mn_2        ...........................................................-............................................................
M1_rs_kb1      ...........................................................-............................................................
M2_rs_kh1      ...........................................................-............................................................
M2_rs_kh2      ...........................................................-............................................................
M2_rs_kh3      ...........................................................-............................................................
M3_rs_kh4      ...........................................................-............................................................
M3_rs_kh5      ...........................................................-............................................................
M3_rs_kh6      ...........................................................-............................................................
M3_rs_kh7      ...........................................................-............................................................
M3_rs_kh8      ...........................................................-............................................................
M3_rs_kh9      ...........................................................-............................................................
M3_rs_kh10     ...........................................................-............................................................
M3_rs_kh11     ...........................................................-............................................................
M3_rs_kh12     ...........................................................-............................................................
M3_rs_kh13     ...........................................................-............................................................
M3_rs_kh14     ...........................................................-............................................................
M3_rs_kh15     ...........................................................-............................................................
M3_rs_kh16     ...........................................................-............................................................
M3_rs_kh17     ...........................................................-............................................................
M3_rs_kh18     ...........................................................-............................................................
M3_rs_kh19     ...........................................................-............................................................
M3_rs_kh20     ...........................................................-............................................................
M3_rs_kh21     ...........................................................-............................................................
M3_rs_kh22     ...........................................................-............................................................
M3_rs_kh23     ...........................................................-............................................................
M3_rs_kh24     ...........................................................-............................................................
M3_rs_kh25     ...........................................................-............................................................
M3_rs_kh26     ...........................................................-............................................................
M3_rs_kh27     ...........................................................-............................................................
M3_rs_kh28     ...........................................................-............................................................
M3_rs_kh29     ...........................................................-............................................................
M3_rs_kh30     ...........................................................-............................................................
M3_rs_kh31     ...........................................................-............................................................
M4_rs_kh32     ...........................................................-............................................................
M5_rs_ot1      ...........................................................-............................................................
M6_rs_ri1      ...........................................................-............................................................
M6_rs_ri2      ...........................................................-............................................................
M7_cn_hj1      ...........................................................-............................................................
M8_cn_hj2      ...........................................................-............................................................
M8_cn_hj3      ...........................................................-............................................................
M8_cn_hj4      ...........................................................-............................................................
M9_cn_hj5      ...........................................................-............................................................
M10_cn_nm1     ...........................................................-............................................................
M11_cn_ul1     ...........................................................-............................................................
M12_cn_sb1     ...........................................................-............................................................
M12_cn_sb2     ...........................................................-............................................................
M13_kr_od1     ...........................................................-............................................................
M14_kr_jm1     ...........................................................-............................................................
M14_kr_jm2     ...........................................................-............................................................
M14_kr_jm3     ...........................................................-............................................................
M15_kr_dg1     ...........................................................-............................................................
M16_kr_dr1     ...........................................................-............................................................
M17_kr_sw1     ...........................................................-............................................................
M17_kr_sw2     ...........................................................-............................................................
M18_kr_hg1     ...........................................................-............................................................
M19_kr_gy1     ...........................................................-............................................................
M20_kr_nh1     ...........................................................-............................................................
M20_kr_nh2     ...........................................................-............................................................
M21_kr_gu1     ...........................................................-............................................................
M22_kr_mp1     ...........................................................-............................................................
M23_kr_bc1     ...........................................................-............................................................
M24_kr_os1     ...........................................................-............................................................
M25_kr_os2     ...........................................................-............................................................
M25_kr_os3     ...........................................................-............................................................
M25_kr_os4     ...........................................................-............................................................
M25_kr_os5     ...........................................................-............................................................
M26_kr_sn1     ...........................................................-............................................................
M27_kr_gn1     ...........................................................-............................................................
M27_kr_gn2     ...........................................................-............................................................
M28_kr_bs1     ...........................................................-............................................................
M28_kr_bs2     ...........................................................-............................................................
M28_kr_bs3     ...........................................................-............................................................
M29_kr_jn1     ...........................................................-............................................................
M30_kr_bl1     ...........................................................-............................................................
M30_kr_bl2     ...........................................................-............................................................
M31_kr_jl1     ...........................................................-.A..........................................................
M31_kr_jl2     ...........................................................-............................................................
M32_kr_mt1     ...........................................................-............................................................
M33_kr_md1     ...........................................................-............................................................
M33_kr_md2     ...........................................................-............................................................
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Appendix 2. (Continued).

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                                                                                                                                    480
A1_kr_gr1      ATTAGAAAATGGAGATTAATGTGTAAAAGAAACAGTATATTGATAAGGATACTTTTTTT-CCAAAATCAAAAGAGCGATTGGGTTGAAAAAATAAAGGATTTCTAATCATCTTCTTAACC
M34_kr_dn1     ...........................................................-............................................................
M34_kr_dn2     ...........................................................-............................................................
M35_kr_sm1     ...........................................................-............................................................
M35_kr_sm2     ...........................................................-............................................................
P1_rs_ms1      ...........................................................-............................................................
P1_rs_ms2      ...........................................................-............................................................
P1_rs_ms3      ...........................................................-............................................................
P1_rs_ms4      ...........................................................-............................................................
P2_rs_nk1      ...........................................................-............................................................
P2_rs_nk2      ...........................................................-............................................................
P3_rs_pr1      ...........................................................-............................................................
P4_rs_pr2      ...........................................................-............................................................
P4_rs_pr3      ...........................................................-............................................................
P5_rs_rc1      ...........................................................-............................................................
P5_rs_rc2      ...........................................................-............................................................
P5_rs_rc3      ...........................................................-............................................................
P6_rs_rc4      ...........................................................-............................................................
P6_rs_rc5      ...........................................................-............................................................
P6_rs_rc6      ...........................................................-............................................................
P6_rs_rc7      ...........................................................-............................................................
P6_rs_rc8      ...........................................................-............................................................
P7_rs_us1      ...........................................................-............................................................
P7_rs_us2      ...........................................................-............................................................
P8_rs_pr4      ...........................................................-............................................................
P9_rs_pr5      ...........................................................-............................................................
P10_cn_jl1     ...........................................................-............................................................
P10_cn_jl2     ...........................................................-............................................................
P11_cn_jl3     ...........................................................-............................................................
P11_cn_jl4     ...........................................................-............................................................
P12_cn_sn1     ...........................................................-............................................................
P12_cn_sn2     ...........................................................-............................................................
P13_cn_mc1     ...........................................................-............................................................
P13_cn_mc2     ...........................................................-............................................................
P14_kr_hw1     ...........................................................-............................................................
P14_kr_hw2     ...........................................................-............................................................
P15_kr_dm1     ...........................................................-............................................................
P15_kr_dm2     ...........................................................-............................................................
P15_kr_dm3     ...........................................................-............................................................
P16_kr_sk1     ...........................................................-............................................................
P16_kr_sk2     ...........................................................-............................................................
P16_kr_sk3     ...........................................................-............................................................
P16_kr_sk4     ...........................................................-............................................................
P16_kr_sk5     ...........................................................-............................................................
P16_kr_sk6     ...........................................................-............................................................
P16_kr_sk7     ...........................................................-............................................................
P16_kr_sk8     ...........................................................-............................................................
P17_kr_sh1     ...........................................................-............................................................
P18_kr_gb1     ...........................................................-............................................................
P19_kr_gw1     ...........................................................-............................................................
P19_kr_gw2     ...........................................................-............................................................
P19_kr_gw3     ...........................................................-............................................................
P20_kr_ck1     ...........................................................-............................................................
P20_kr_ck2     ...........................................................-............................................................
P21_kr_hc1     ...........................................................-............................................................
P22_kr_hb1     ...........................................................-............................................................
P23_kr_hb2     ...........................................................-............................................................
P24_kr_mh1     ...........................................................-............................................................
P24_kr_mh2     ...........................................................-............................................................
p25_kr_tb1     ...........................................................-............................................................
p25_kr_tb2     ...........................................................-............................................................
P26_kr_tb3     ...........................................................-............................................................
P27_kr_so1     ...........................................................-............................................................
P27_kr_so2     ...........................................................-............................................................
P27_kr_so3     ...........................................................-............................................................
P27_kr_so4     ...........................................................-............................................................
P27_kr_so5     ...........................................................-............................................................
P27_kr_so6     ...........................................................-............................................................
P28_kr_il1     ...........................................................-............................................................
P29_kr_mj1     ...........................................................-............................................................
P29_kr_mj2     ...........................................................-............................................................
P30_kr_dk1     ...........................................................-............................................................
P31_kr_jr1     ...........................................................-............................................................
P32_kr_jr2     ...........................................................-............................................................
O1_jp_rb1      ...........................................................-............................................................
O2_jp_hk1      ...........................................................-............................................................
O2_jp_hk2      ...........................................................-............................................................
O2_jp_hk3      ...........................................................-............................................................
O2_jp_hk4      ...........................................................-............................................................
J1_jp_hn1      ...........................................................-............................................................
J1_jp_hn2      ...........................................................-............................................................
J2_jp_ky1      ...........................................................-............................................................
J3_jp_jp1      ...........................................................-............................................................
B1_cn_bj1      ...........................................................-............................................................
B2_uk_1        ...........................................................-............................................................
AMP_cn_1       ...C.......................................................-............................................................
SUF_kr_hl1     ...........................................................T............................................................
SUF_kr_hl2     ...........................................................T............................................................
```

Appendix 2. (Continued).

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                                                                                                                                      600
A1_kr_gr1       TATAACTATCAATAAAGAAACCAATTAGATGCTAGATGGAAAAAAGATAGAGAGTCCGTTGATGAGTTTAGCTGTCTCCAAGGTATCTATCGATTATTTTGTACTAGAATACCTTGTTTT
A1_kr_gr2       ........................................................................................................................
A2_kr_hl1       ........................................................................................................................
A2_kr_hl2       ........................................................................................................................
A2_kr_hl3       ........................................................................................................................
A2_kr_hl4       ........................................................................................................................
A3_kr_hl5       ........................................................................................................................
A3_kr_hl6       ........................................................................................................................
A3_kr_hl7       ........................................................................................................................
A3_kr_hl8       ........................................................................................................................
A4_kr_hl9       ........................................................................................................................
A5_kr_hl10      ........................................................................................................................
A5_kr_hl11      ........................................................................................................................
A5_kr_hl12      ........................................................................................................................
A5_kr_hl13      ........................................................................................................................
A5_kr_hl14      ........................................................................................................................
A7_mn_1         ........................................................................................................................
A8_mn_2         ........................................................................................................................
M1_rs_kb1       ........................................................................................................................
M2_rs_kh1       ........................................................................................................................
M2_rs_kh2       ........................................................................................................................
M2_rs_kh3       ........................................................................................................................
M3_rs_kh4       ........................................................................................................................
M3_rs_kh5       ........................................................................................................................
M3_rs_kh6       ........................................................................................................................
M3_rs_kh7       ........................................................................................................................
M3_rs_kh8       ........................................................................................................................
M3_rs_kh9       ........................................................................................................................
M3_rs_kh10      ........................................................................................................................
M3_rs_kh11      ........................................................................................................................
M3_rs_kh12      ........................................................................................................................
M3_rs_kh13      ........................................................................................................................
M3_rs_kh14      ........................................................................................................................
M3_rs_kh15      ........................................................................................................................
M3_rs_kh16      ........................................................................................................................
M3_rs_kh17      ........................................................................................................................
M3_rs_kh18      ........................................................................................................................
M3_rs_kh19      ........................................................................................................................
M3_rs_kh20      ........................................................................................................................
M3_rs_kh21      ........................................................................................................................
M3_rs_kh22      ........................................................................................................................
M3_rs_kh23      ........................................................................................................................
M3_rs_kh24      ........................................................................................................................
M3_rs_kh25      ........................................................................................................................
M3_rs_kh26      ........................................................................................................................
M3_rs_kh27      ........................................................................................................................
M3_rs_kh28      ........................................................................................................................
M3_rs_kh29      ........................................................................................................................
M3_rs_kh30      ........................................................................................................................
M3_rs_kh31      ........................................................................................................................
M4_rs_kh32      ........................................................................................................................
M5_rs_ot1       ........................................................................................................................
M6_rs_ri1       ........................................................................................................................
M6_rs_ri2       ........................................................................................................................
M7_cn_hj1       ........................................................................................................................
M8_cn_hj2       ........................................................................................................................
M8_cn_hj3       ........................................................................................................................
M8_cn_hj4       ........................................................................................................................
M9_cn_hj5       ........................................................................................................................
M10_cn_nm1      ........................................................................................................................
M11_cn_ul1      ........................................................................................................................
M12_cn_sb1      ........................................................................................................................
M12_cn_sb2      ........................................................................................................................
M13_kr_od1      ........................................................................................................................
M14_kr_jm1      ........................................................................................................................
M14_kr_jm2      ........................................................................................................................
M14_kr_jm3      ........................................................................................................................
M15_kr_dg1      ........................................................................................................................
M16_kr_dr1      ........................................................................................................................
M17_kr_sw1      ........................................................................................................................
M17_kr_sw2      ........................................................................................................................
M18_kr_hg1      ........................................................................................................................
M19_kr_gy1      ........................................................................................................................
M20_kr_nh1      ........................................................................................................................
M20_kr_nh2      ........................................................................................................................
M21_kr_gu1      ........................................................................................................................
M22_kr_mp1      ........................................................................................................................
M23_kr_bc1      ........................................................................................................................
M24_kr_os1      ........................................................................................................................
M25_kr_os2      ........................................................................................................................
M25_kr_os3      ........................................................................................................................
M25_kr_os4      ........................................................................................................................
M25_kr_os5      ........................................................................................................................
M26_kr_sn1      ........................................................................................................................
M27_kr_gn1      ........................................................................................................................
M27_kr_gn2      ........................................................................................................................
M28_kr_bs1      ........................................................................................................................
M28_kr_bs2      ........................................................................................................................
M28_kr_bs3      ........................................................................................................................
M29_kr_jn1      ........................................................................................................................
M30_kr_bl1      ........................................................................................................................
M30_kr_bl2      ........................................................................................................................
M31_kr_jl1      ........................................................................................................................
M31_kr_jl2      ........................................................................................................................
M32_kr_mt1      ........................................................................................................................
M33_kr_md1      ........................................................................................................................
M33_kr_md2      ........................................................................................................................
```

Appendix 2. (Continued).

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                                                                                                                                  720
A1_kr_gr1      TATAACTATCAATAAAGAAACCAATTAGATGCTAGATGGAAAAAAGATAGAGAGTCCGTTGATGAGTTTAGCTGTCTCCAAGGTATCTATCGATTATTTTGTACTAGAATACCTTGTTTT
M34_kr_dn1     ........................................................................................................................
M34_kr_dn2     ........................................................................................................................
M35_kr_sm1     ........................................................................................................................
M35_kr_sm2     ........................................................................................................................
P1_rs_ms1      ........................................................................................................................
P1_rs_ms2      ........................................................................................................................
P1_rs_ms3      ........................................................................................................................
P1_rs_ms4      ........................................................................................................................
P2_rs_nk1      ........................................................................................................................
P2_rs_nk2      ........................................................................................................................
P3_rs_pr1      ........................................................................................................................
P4_rs_pr2      ........................................................................................................................
P4_rs_pr3      ........................................................................................................................
P5_rs_rc1      ........................................................................................................................
P5_rs_rc2      ........................................................................................................................
P5_rs_rc3      ........................................................................................................................
P6_rs_rc4      ........................................................................................................................
P6_rs_rc5      ........................................................................................................................
P6_rs_rc6      ........................................................................................................................
P6_rs_rc7      ........................................................................................................................
P6_rs_rc8      ........................................................................................................................
P7_rs_us1      ........................................................................................................................
P7_rs_us2      ........................................................................................................................
P8_rs_pr4      ........................................................................................................................
P9_rs_pr5      ........................................................................................................................
P10_cn_jl1     ........................................................................................................................
P10_cn_jl2     ........................................................................................................................
P11_cn_jl3     ........................................................................................................................
P11_cn_jl4     ........................................................................................................................
P12_cn_sn1     ........................................................................................................................
P12_cn_sn2     ........................................................................................................................
P13_cn_mc1     ........................................................................................................................
P13_cn_mc2     ........................................................................................................................
P14_kr_hw1     ........................................................................................................................
P14_kr_hw2     ........................................................................................................................
P15_kr_dm1     ........................................................................................................................
P15_kr_dm2     ........................................................................................................................
P15_kr_dm3     ........................................................................................................................
P16_kr_sk1     ........................................................................................................................
P16_kr_sk2     ........................................................................................................................
P16_kr_sk3     ........................................................................................................................
P16_kr_sk4     ........................................................................................................................
P16_kr_sk5     ........................................................................................................................
P16_kr_sk6     ........................................................................................................................
P16_kr_sk7     ........................................................................................................................
P16_kr_sk8     ........................................................................................................................
P17_kr_sh1     ........................................................................................................................
P18_kr_gb1     ........................................................................................................................
P19_kr_gw1     ........................................................................................................................
P19_kr_gw2     ........................................................................................................................
P19_kr_gw3     ........................................................................................................................
P20_kr_ck1     ........................................................................................................................
P20_kr_ck2     ........................................................................................................................
P21_kr_hc1     ........................................................................................................................
P22_kr_hb1     ........................................................................................................................
P23_kr_hb2     ........................................................................................................................
P24_kr_mh1     ........................................................................................................................
P24_kr_mh2     ........................................................................................................................
p25_kr_tb1     ........................................................................................................................
p25_kr_tb2     ........................................................................................................................
P26_kr_tb3     ........................................................................................................................
P27_kr_so1     ........................................................................................................................
P27_kr_so2     ........................................................................................................................
P27_kr_so3     ........................................................................................................................
P27_kr_so4     ........................................................................................................................
P27_kr_so5     ........................................................................................................................
P27_kr_so6     ........................................................................................................................
P28_kr_il1     ........................................................................................................................
P29_kr_mj1     ........................................................................................................................
P29_kr_mj2     ........................................................................................................................
P30_kr_dk1     ........................................................................................................................
P31_kr_jr1     ........................................................................................................................
P32_kr_jr2     ........................................................................................................................
O1_jp_rb1      ........................................................................................................................
O2_jp_hk1      ........................................................................................................................
O2_jp_hk2      ........................................................................................................................
O2_jp_hk3      ........................................................................................................................
O2_jp_hk4      ........................................................................................................................
J1_jp_hn1      ........................................................................................................................
J1_jp_hn2      ........................................................................................................................
J2_jp_ky1      ........................................................................................................................
J3_jp_jp1      .............................................................................................C..........................
B1_cn_bj1      ........................................................................................................................
B2_uk_1        ........................................................................................................................
AMP_cn_1       ............G..................G............-...........................................................................
SUF_kr_hl1     ............G........A......C..G........................................................................................
SUF_kr_hl2     ............G........A......C..G........................................................................................
```

Appendix 2. (Continued).

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                                                                                                                                     720
A1_kr_gr1      GACTGTATCGCACTA-TGTACCATTTTATAATCCACGAAACCCTCTACTTTTCCTTTTGTTTCCAGTTTCATTTTAAATGGAAGAATTCCAAGGATATTTAGAACTCGACAGATCTTGGC
A1_kr_gr2      ...............-........................................................................................................
A2_kr_hl1      ...............-........................................................................................................
A2_kr_hl2      ...............-........................................................................................................
A2_kr_hl3      ...............-........................................................................................................
A2_kr_hl4      ...............-........................................................................................................
A3_kr_hl5      ...............-........................................................................................................
A3_kr_hl6      ...............-........................................................................................................
A3_kr_hl7      ...............-........................................................................................................
A3_kr_hl8      ...............-........................................................................................................
A4_kr_hl9      ...............-........................................................................................................
A5_kr_hl10     ...............-........................................................................................................
A5_kr_hl11     ...............-........................................................................................................
A5_kr_hl12     ...............-........................................................................................................
A5_kr_hl13     ...............-........................................................................................................
A5_kr_hl14     ...............-........................................................................................................
A7_mn_1        ...............-........................................................................................................
A8_mn_2        ...............-........................................................................................................
M1_rs_kb1      ...............-........................................................................................................
M2_rs_kh1      ...............-........................................................................................................
M2_rs_kh2      ...............-........................................................................................................
M2_rs_kh3      ...............-........................................................................................................
M3_rs_kh4      ...............-........................................................................................................
M3_rs_kh5      ...............-........................................................................................................
M3_rs_kh6      ...............-........................................................................................................
M3_rs_kh7      ...............-........................................................................................................
M3_rs_kh8      ...............-........................................................................................................
M3_rs_kh9      ...............-........................................................................................................
M3_rs_kh10     ...............-........................................................................................................
M3_rs_kh11     ...............-........................................................................................................
M3_rs_kh12     ...............-........................................................................................................
M3_rs_kh13     ...............-........................................................................................................
M3_rs_kh14     ...............-........................................................................................................
M3_rs_kh15     ...............-........................................................................................................
M3_rs_kh16     ...............-........................................................................................................
M3_rs_kh17     ...............-........................................................................................................
M3_rs_kh18     ...............-........................................................................................................
M3_rs_kh19     ...............-........................................................................................................
M3_rs_kh20     ...............-........................................................................................................
M3_rs_kh21     ...............-........................................................................................................
M3_rs_kh22     ...............-........................................................................................................
M3_rs_kh23     ...............-........................................................................................................
M3_rs_kh24     ...............-........................................................................................................
M3_rs_kh25     ...............-........................................................................................................
M3_rs_kh26     ...............-........................................................................................................
M3_rs_kh27     ...............-........................................................................................................
M3_rs_kh28     ...............-........................................................................................................
M3_rs_kh29     ...............-........................................................................................................
M3_rs_kh30     ...............-........................................................................................................
M3_rs_kh31     ...............-........................................................................................................
M6_rs_ri1      ...............-........................................................................................................
M6_rs_ri2      ...............-........................................................................................................
M4_rs_kh32     ...............-........................................................................................................
M5_rs_ot1      ...............-........................................................................................................
M7_cn_hj1      ...............-........................................................................................................
M8_cn_hj2      ...............-........................................................................................................
M8_cn_hj3      ...............-........................................................................................................
M8_cn_hj4      ...............-........................................................................................................
M9_cn_hj5      ...............-........................................................................................................
M10_cn_nm1     ...............-........................................................................................................
M11_cn_ul1     ...............-........................................................................................................
M12_cn_sb1     ...............-........................................................................................................
M12_cn_sb2     ...............-........................................................................................................
M13_kr_od1     ...............-........................................................................................................
M14_kr_jm1     ...............-........................................................................................................
M14_kr_jm2     ...............-........................................................................................................
M14_kr_jm3     ...............-........................................................................................................
M15_kr_dg1     ...............-........................................................................................................
M16_kr_dr1     ...............-........................................................................................................
M17_kr_sw1     ...............-........................................................................................................
M17_kr_sw2     ...............-........................................................................................................
M18_kr_hg1     ...............-........................................................................................................
M19_kr_gy1     ...............-........................................................................................................
M20_kr_nh1     ...............-........................................................................................................
M20_kr_nh2     ...............-........................................................................................................
M21_kr_gu1     ...............-........................................................................................................
M22_kr_mp1     ...............-........................................................................................................
M23_kr_bc1     ...............-........................................................................................................
M24_kr_os1     ...............-........................................................................................................
M25_kr_os2     ...............-........................................................................................................
M25_kr_os3     ...............-........................................................................................................
M25_kr_os4     ...............-........................................................................................................
M25_kr_os5     ...............A........................................................................................................
M26_kr_sn1     ...............-........................................................................................................
M27_kr_gn1     ...............-........................................................................................................
M27_kr_gn2     ...............-........................................................................................................
M28_kr_bs1     ...............-........................................................................................................
M28_kr_bs2     ...............-........................................................................................................
M28_kr_bs3     ...............-........................................................................................................
M29_kr_jn1     ...............-........................................................................................................
M30_kr_bl1     ...............-........................................................................................................
M30_kr_bl2     ...............-........................................................................................................
M31_kr_jl1     ...............-........................................................................................................
M31_kr_jl2     ...............-........................................................................................................
M32_kr_mt1     ...............-........................................................................................................
M33_kr_md1     ...............-........................................................................................................
M33_kr_md2     ...............-........................................................................................................
```

Appendix 2. (Continued).

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                                                                                                                                           720
A1_kr_gr1      GACTGTATCGCACTA-TGTACCATTTTATAATCCACGAAACCCTCTACTTTTCCTTTTGTTTCCAGTTTCATTTTAAATGGAAGAATTCCAAGGATATTTAGAACTCGACAGATCTTGGC
M34_kr_dn1     ...............-........................................................................................................
M34_kr_dn2     ...............-........................................................................................................
M35_kr_sm1     ...............-........................................................................................................
M35_kr_sm2     ...............-........................................................................................................
P1_rs_ms1      ...............-........................................................................................................
P1_rs_ms2      ...............-........................................................................................................
P1_rs_ms3      ...............-........................................................................................................
P1_rs_ms4      ...............-........................................................................................................
P2_rs_nk1      ...............-........................................................................................................
P2_rs_nk2      ...............-........................................................................................................
P3_rs_pr1      ...............-........................................................................................................
P4_rs_pr2      ...............-........................................................................................................
P4_rs_pr3      ...............-........................................................................................................
P5_rs_rc1      ...............-........................................................................................................
P5_rs_rc2      ...............-........................................................................................................
P5_rs_rc3      ...............-........................................................................................................
P6_rs_rc4      ...............-........................................................................................................
P6_rs_rc5      ...............-........................................................................................................
P6_rs_rc6      ...............-........................................................................................................
P6_rs_rc7      ...............-........................................................................................................
P6_rs_rc8      ...............-........................................................................................................
P7_rs_us1      ...............-........................................................................................................
P7_rs_us2      ...............-........................................................................................................
P8_rs_pr4      ...............-........................................................................................................
P9_rs_pr5      ...............-........................................................................................................
P10_cn_jl1     ...............-........................................................................................................
P10_cn_jl2     ...............-........................................................................................................
P11_cn_jl3     ...............-........................................................................................................
P11_cn_jl4     ...............-........................................................................................................
P12_cn_sn1     ...............-........................................................................................................
P12_cn_sn2     ...............-........................................................................................................
P13_cn_mc1     ...............-........................................................................................................
P13_cn_mc2     ...............-........................................................................................................
P14_kr_hw1     ...............-........................................................................................................
P14_kr_hw2     ...............-........................................................................................................
P15_kr_dm1     ...............-........................................................................................................
P15_kr_dm2     ...............-........................................................................................................
P15_kr_dm3     ...............-........................................................................................................
P16_kr_sk1     ...............-........................................................................................................
P16_kr_sk2     ...............-........................................................................................................
P16_kr_sk3     ...............-........................................................................................................
P16_kr_sk4     ...............-........................................................................................................
P16_kr_sk5     ...............-........................................................................................................
P16_kr_sk6     ...............-........................................................................................................
P16_kr_sk7     ...............-........................................................................................................
P16_kr_sk8     ...............-........................................................................................................
P17_kr_sh1     ...............-........................................................................................................
P18_kr_gb1     ...............-........................................................................................................
P19_kr_gw1     ...............-........................................................................................................
P19_kr_gw2     ...............-........................................................................................................
P19_kr_gw3     ...............-........................................................................................................
P20_kr_ck1     ...............-........................................................................................................
P20_kr_ck2     ...............-........................................................................................................
P21_kr_hc1     ...............-........................................................................................................
P22_kr_hb1     ...............-........................................................................................................
P23_kr_hb2     ...............-........................................................................................................
P24_kr_mh1     ...............-........................................................................................................
P24_kr_mh2     ...............-........................................................................................................
p25_kr_tb1     ...............-........................................................................................................
p25_kr_tb2     ...............-........................................................................................................
P26_kr_tb3     ...............-........................................................................................................
P27_kr_so1     ...............-........................................................................................................
P27_kr_so2     ...............-........................................................................................................
P27_kr_so3     ...............-........................................................................................................
P27_kr_so4     ...............-........................................................................................................
P27_kr_so5     ...............-........................................................................................................
P27_kr_so6     ...............-........................................................................................................
P28_kr_il1     ...............-........................................................................................................
P29_kr_mj1     ...............-........................................................................................................
P29_kr_mj2     ...............-........................................................................................................
P30_kr_dk1     ...............-........................................................................................................
P31_kr_jr1     ...............-........................................................................................................
P32_kr_jr2     ...............-........................................................................................................
O1_jp_rb1      ...............-........................................................................................................
O2_jp_hk1      ...............-........................................................................................................
O2_jp_hk2      ...............-........................................................................................................
O2_jp_hk3      ...............-........................................................................................................
O2_jp_hk4      ...............-........................................................................................................
J1_jp_hn1      ...............-........................................................................................................
J1_jp_hn2      ...............-........................................................................................................
J2_jp_ky1      ...............-........................................................................................................
J3_jp_jp1      ...............-........................................................................................................
B1_cn_bj1      ...............-........................................................................................................
B2_uk_1        ...............-........................................................................................................
AMP_cn_1       ...............-......................................................G...........................................T.....
SUF_kr_hl1     ...............-........................................................................................................
SUF_kr_hl2     ...............-........................................................................................................
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Appendix 2. (Continued).

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                                                                                                                                     840
A1_kr_gr1      AAGACGATTTTTTATATCCACTTCTCTTTCAGGAATATATTTATGCACTTGTACACGATCAGGATTTATATTTAAATAGGCCCGTTTTATTGTCAAATACAAAAAAAAGGGGTGATGACA
A1_kr_gr2      ........................................................................................................................
A2_kr_hl1      ........................................................................................................................
A2_kr_hl2      ........................................................................................................................
A2_kr_hl3      .....................................................................................................................G..
A2_kr_hl4      ........................................................................................................................
A3_kr_hl5      ........................................................................................................................
A3_kr_hl6      .....................................................................................................................G..
A3_kr_hl7      ........................................................................................................................
A3_kr_hl8      ........................................................................................................................
A4_kr_hl9      ........................................................................................................................
A5_kr_hl10     ........................................................................................................................
A5_kr_hl11     .....................................................................................................................G..
A5_kr_hl12     ........................................................................................................................
A5_kr_hl13     .....................................................................................................................G..
A5_kr_hl14     ........................................................................................................................
A7_mn_1        ........................................................................................................................
A8_mn_2        ........................................................................................................................
M1_rs_kb1      ........................................................................................................................
M2_rs_kh1      ........................................................................................................................
M2_rs_kh2      ........................................................................................................................
M2_rs_kh3      ........................................................................................................................
M3_rs_kh4      ........................................................................................................................
M3_rs_kh5      ........................................................................................................................
M3_rs_kh6      ........................................................................................................................
M3_rs_kh7      ........................................................................................................................
M3_rs_kh8      ........................................................................................................................
M3_rs_kh9      ........................................................................................................................
M3_rs_kh10     ........................................................................................................................
M3_rs_kh11     ........................................................................................................................
M3_rs_kh12     ........................................................................................................................
M3_rs_kh13     ........................................................................................................................
M3_rs_kh14     ........................................................................................................................
M3_rs_kh15     ........................................................................................................................
M3_rs_kh16     ........................................................................................................................
M3_rs_kh17     ........................................................................................................................
M3_rs_kh18     ........................................................................................................................
M3_rs_kh19     ........................................................................................................................
M3_rs_kh20     ........................................................................................................................
M3_rs_kh21     ........................................................................................................................
M3_rs_kh22     ........................................................................................................................
M3_rs_kh23     ........................................................................................................................
M3_rs_kh24     ........................................................................................................................
M3_rs_kh25     ........................................................................................................................
M3_rs_kh26     ........................................................................................................................
M3_rs_kh27     ........................................................................................................................
M3_rs_kh28     ........................................................................................................................
M3_rs_kh29     ........................................................................................................................
M3_rs_kh30     ........................................................................................................................
M3_rs_kh31     ........................................................................................................................
M4_rs_kh32     ........................................................................................................................
M5_rs_ot1      ...................................................................................................A.......G............
M6_rs_ri1      .............................................................................................T..........................
M6_rs_ri2      ........................................................................................................................
M7_cn_hj1      ........................................................................................................................
M8_cn_hj2      ........................................................................................................................
M8_cn_hj3      ........................................................................................................................
M8_cn_hj4      ........................................................................................................................
M9_cn_hj5      ........................................................................................................................
M10_cn_nm1     ........................................................................................................................
M11_cn_ul1     ........................................................................................................................
M12_cn_sb1     ........................................................................................................................
M12_cn_sb2     ........................................................................................................................
M13_kr_od1     ........................................................................................................................
M14_kr_jm1     ........................................................................................................................
M14_kr_jm2     ........................................................................................................................
M14_kr_jm3     ........................................................................................................................
M15_kr_dg1     ........................................................................................................................
M16_kr_dr1     ........................................................................................................................
M17_kr_sw1     ........................................................................................................................
M17_kr_sw2     ........................................................................................................................
M18_kr_hg1     ........................................................................................................................
M19_kr_gy1     ........................................................................................................................
M20_kr_nh1     ........................................................................................................................
M20_kr_nh2     ........................................................................................................................
M21_kr_gu1     ........................................................................................................................
M22_kr_mp1     ........................................................................................................................
M23_kr_bc1     ........................................................................................................................
M24_kr_os1     ........................................................................................................................
M25_kr_os2     ........................................................................................................................
M25_kr_os3     ........................................................................................................................
M25_kr_os4     ........................................................................................................................
M25_kr_os5     ........................................................................................................................
M26_kr_sn1     ........................................................................................................................
M27_kr_gn1     ........................................................................................................................
M27_kr_gn2     ........................................................................................................................
M28_kr_bs1     ........................................................................................................................
M28_kr_bs2     ........................................................................................................................
M28_kr_bs3     ........................................................................................................................
M29_kr_jn1     ........................................................................................................................
M30_kr_bl1     ........................................................................................................................
M30_kr_bl2     ........................................................................................................................
M31_kr_jl1     ........................................................................................................................
M31_kr_jl2     ........................................................................................................................
M32_kr_mt1     ........................................................................................................................
M33_kr_md1     .....................................................................................................................G..
M33_kr_md2     .....................................................................................................................G..
```

Appendix 2. (Continued).

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                                                                                                                                     840
A1_kr_gr1      AAGACGATTTTTTATATCCACTTCTCTTTCAGGAATATATTTATGCACTTGTACACGATCAGGATTTATATTTAAATAGGCCCGTTTTATTGTCAAATACAAAAAAAAGGGGTGATGACA
M34_kr_dn1     ........................................................................................................................
M34_kr_dn2     ........................................................................................................................
M35_kr_sm1     ........................................................................................................................
M35_kr_sm2     ........................................................................................................................
P1_rs_ms1      ........................................................................................................................
P1_rs_ms2      ........................................................................................................................
P1_rs_ms3      ........................................................................................................................
P1_rs_ms4      ........................................................................................................................
P2_rs_nk1      ........................................................................................................................
P2_rs_nk2      ........................................................................................................................
P3_rs_pr1      ........................................................................................................................
P4_rs_pr2      ........................................................................................................................
P4_rs_pr3      .............................................................................................T..........................
P5_rs_rc1      ...................................................................................................A.......G............
P5_rs_rc2      ........................................................................................................................
P5_rs_rc3      ........................................................................................................................
P6_rs_rc4      ........................................................................................................................
P6_rs_rc5      ........................................................................................................................
P6_rs_rc6      ........................................................................................................................
P6_rs_rc7      ........................................................................................................................
P6_rs_rc8      ........................................................................................................................
P7_rs_us1      ........................................................................................................................
P7_rs_us2      ........................................................................................................................
P8_rs_pr4      ........................................................................................................................
P9_rs_pr5      ...................................................................................................A.......G............
P10_cn_jl1     ........................................................................................................................
P10_cn_jl2     ........................................................................................................................
P11_cn_jl3     ........................................................................................................................
P11_cn_jl4     ........................................................................................................................
P12_cn_sn1     ........................................................................................................................
P12_cn_sn2     ........................................................................................................................
P13_cn_mc1     ........................................................................................................................
P13_cn_mc2     ........................................................................................................................
P14_kr_hw1     ........................................................................................................................
P14_kr_hw2     ........................................................................................................................
P15_kr_dm1     ........................................................................................................................
P15_kr_dm2     ........................................................................................................................
P15_kr_dm3     ........................................................................................................................
P16_kr_sk1     ........................................................................................................................
P16_kr_sk2     ........................................................................................................................
P16_kr_sk3     ........................................................................................................................
P16_kr_sk4     ........................................................................................................................
P16_kr_sk5     ........................................................................................................................
P16_kr_sk6     ........................................................................................................................
P16_kr_sk7     ........................................................................................................................
P16_kr_sk8     ........................................................................................................................
P17_kr_sh1     ........................................................................................................................
P18_kr_gb1     ........................................................................................................................
P19_kr_gw1     ........................................................................................................................
P19_kr_gw2     ........................................................................................................................
P19_kr_gw3     ........................................................................................................................
P20_kr_ck1     ........................................................................................................................
P20_kr_ck2     ........................................................................................................................
P21_kr_hc1     ........................................................................................................................
P22_kr_hb1     ........................................................................................................................
P23_kr_hb2     ........................................................................................................................
P24_kr_mh1     ........................................................................................................................
P24_kr_mh2     ........................................................................................................................
p25_kr_tb1     ........................................................................................................................
p25_kr_tb2     ........................................................................................................................
P26_kr_tb3     ........................................................................................................................
P27_kr_so1     ........................................................................................................................
P27_kr_so2     ........................................................................................................................
P27_kr_so3     ........................................................................................................................
P27_kr_so4     ........................................................................................................................
P27_kr_so5     ........................................................................................................................
P27_kr_so6     ........................................................................................................................
P28_kr_il1     ........................................................................................................................
P29_kr_mj1     ........................................................................................................................
P29_kr_mj2     ........................................................................................................................
P30_kr_dk1     ........................................................................................................................
P31_kr_jr1     ........................................................................................................................
P32_kr_jr2     ........................................................................................................................
O1_jp_rb1      ........................................................................................................................
O2_jp_hk1      ........................................................................................................................
O2_jp_hk2      ........................................................................................................................
O2_jp_hk3      ........................................................................................................................
O2_jp_hk4      ........................................................................................................................
J1_jp_hn1      ........................................................................................................................
J1_jp_hn2      ........................................................................................................................
J2_jp_ky1      ........................................................................................................................
J3_jp_jp1      ........................................................................................................................
B1_cn_bj1      ........................................................................................................................
B2_uk_1        ........................................................................................................................
AMP_cn_1       .......................A................................................................................................
SUF_kr_hl1     .......................A................................................................G...............................
SUF_kr_hl2     .......................A................................................................G...............................
```

Appendix 2. (Continued).

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                                                                                                                                     960
A1_kr_gr1      CAAAGTACAGTTTACTAGTTGTAAGACGTTTAGTTATTCGAATGTATCAACAGAATCATTCGATTCTTTCTGTTAATGATTCTAATAAAAATAAATTTATTGTACTCCCCCAAAATTTGT
A1_kr_gr2      ........................................................................................................................
A2_kr_hl1      ........................................................................................................................
A2_kr_hl2      ........................................................................................................................
A2_kr_hl3      ........................................................................................................................
A2_kr_hl4      ........................................................................................................................
A3_kr_hl5      ........................................................................................................................
A3_kr_hl6      ........................................................................................................................
A3_kr_hl7      ........................................................................................................................
A3_kr_hl8      ........................................................................................................................
A4_kr_hl9      ........................................................................................................................
A5_kr_hl10     ........................................................................................................................
A5_kr_hl11     ........................................................................................................................
A5_kr_hl12     ........................................................................................................................
A5_kr_hl13     ........................................................................................................................
A5_kr_hl14     ........................................................................................................................
A7_mn_1        ........................................................................................................................
A8_mn_2        ........................................................................................................................
M1_rs_kb1      ........................................................................................................................
M2_rs_kh1      ........................................................................................................................
M2_rs_kh2      ........................................................................................................................
M2_rs_kh3      ........................................................................................................................
M3_rs_kh4      ........................................................................................................................
M3_rs_kh5      ........................................................................................................................
M3_rs_kh6      ........................................................................................................................
M3_rs_kh7      ........................................................................................................................
M3_rs_kh8      ........................................................................................................................
M3_rs_kh9      ........................................................................................................................
M3_rs_kh10     ........................................................................................................................
M3_rs_kh11     ........................................................................................................................
M3_rs_kh12     ........................................................................................................................
M3_rs_kh13     ........................................................................................................................
M3_rs_kh14     ........................................................................................................................
M3_rs_kh15     ........................................................................................................................
M3_rs_kh16     ........................................................................................................................
M3_rs_kh17     ........................................................................................................................
M3_rs_kh18     ........................................................................................................................
M3_rs_kh19     ........................................................................................................................
M3_rs_kh20     ........................................................................................................................
M3_rs_kh21     ........................................................................................................................
M3_rs_kh22     ........................................................................................................................
M3_rs_kh23     ........................................................................................................................
M3_rs_kh24     ........................................................................................................................
M3_rs_kh25     ........................................................................................................................
M3_rs_kh26     ........................................................................................................................
M3_rs_kh27     ........................................................................................................................
M3_rs_kh28     ........................................................................................................................
M3_rs_kh29     ........................................................................................................................
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M3_rs_kh31     ........................................................................................................................
M4_rs_kh32     ........................................................................................................................
M5_rs_ot1      ........................................................................................................................
M6_rs_ri1      ........................................................................................................................
M6_rs_ri2      ........................................................................................................................
M7_cn_hj1      ........................................................................................................................
M8_cn_hj2      ........................................................................................................................
M8_cn_hj3      ........................................................................................................................
M8_cn_hj4      ........................................................................................................................
M9_cn_hj5      ........................................................................................................................
M10_cn_nm1     ........................................................................................................................
M11_cn_ul1     ........................................................................................................................
M12_cn_sb1     ........................................................................................................................
M12_cn_sb2     ........................................................................................................................
M13_kr_od1     ........................................................................................................................
M14_kr_jm1     ........................................................................................................................
M14_kr_jm2     ........................................................................................................................
M14_kr_jm3     ........................................................................................................................
M15_kr_dg1     ........................................................................................................................
M16_kr_dr1     ........................................................................................................................
M17_kr_sw1     ........................................................................................................................
M17_kr_sw2     ........................................................................................................................
M18_kr_hg1     ........................................................................................................................
M19_kr_gy1     ........................................................................................................................
M20_kr_nh1     ........................................................................................................................
M20_kr_nh2     ........................................................................................................................
M21_kr_gu1     ........................................................................................................................
M22_kr_mp1     ........................................................................................................................
M23_kr_bc1     ........................................................................................................................
M24_kr_os1     ........................................................................................................................
M25_kr_os2     ........................................................................................................................
M25_kr_os3     ........................................................................................................................
M25_kr_os4     ........................................................................................................................
M25_kr_os5     ........................................................................................................................
M26_kr_sn1     ........................................................................................................................
M27_kr_gn1     ........................................................................................................................
M27_kr_gn2     ........................................................................................................................
M28_kr_bs1     ........................................................................................................................
M28_kr_bs2     ........................................................................................................................
M28_kr_bs3     ........................................................................................................................
M29_kr_jn1     ........................................................................................................................
M30_kr_bl1     ........................................................................................................................
M30_kr_bl2     ........................................................................................................................
M31_kr_jl1     ..............................................................................................................A.........
M31_kr_jl2     ........................................................................................................................
M32_kr_mt1     ........................................................................................................................
M33_kr_md1     ........................................................................................................................
M33_kr_md2     ........................................................................................................................
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Appendix 2. (Continued).

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                                                                                                                                     960
A1_kr_gr1      CAAAGTACAGTTTACTAGTTGTAAGACGTTTAGTTATTCGAATGTATCAACAGAATCATTCGATTCTTTCTGTTAATGATTCTAATAAAAATAAATTTATTGTACTCCCCCAAAATTTGT
M34_kr_dn1     ........................................................................................................................
M34_kr_dn2     ........................................................................................................................
M35_kr_sm1     ........................................................................................................................
M35_kr_sm2     ........................................................................................................................
P1_rs_ms1      ........................................................................................................................
P1_rs_ms2      ........................................................................................................................
P1_rs_ms3      ........................................................................................................................
P1_rs_ms4      ........................................................................................................................
P2_rs_nk1      ........................................................................................................................
P2_rs_nk2      ........................................................................................................................
P3_rs_pr1      ........................................................................................................................
P4_rs_pr2      ........................................................................................................................
P4_rs_pr3      ........................................................................................................................
P5_rs_rc1      ........................................................................................................................
P5_rs_rc2      ........................................................................................................................
P5_rs_rc3      ........................................................................................................................
P6_rs_rc4      ........................................................................................................................
P6_rs_rc5      ........................................................................................................................
P6_rs_rc6      ........................................................................................................................
P6_rs_rc7      ........................................................................................................................
P6_rs_rc8      ........................................................................................................................
P7_rs_us1      ........................................................................................................................
P7_rs_us2      ........................................................................................................................
P8_rs_pr4      ........................................................................................................................
P9_rs_pr5      ........................................................................................................................
P10_cn_jl1     ........................................................................................................................
P10_cn_jl2     ........................................................................................................................
P11_cn_jl3     ........................................................................................................................
P11_cn_jl4     ........................................................................................................................
P12_cn_sn1     ........................................................................................................................
P12_cn_sn2     ........................................................................................................................
P13_cn_mc1     ........................................................................................................................
P13_cn_mc2     ........................................................................................................................
P14_kr_hw1     ........................................................................................................................
P14_kr_hw2     ........................................................................................................................
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P16_kr_sk8     ........................................................................................................................
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P19_kr_gw1     ........................................................................................................................
P19_kr_gw2     ........................................................................................................................
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P22_kr_hb1     ........................................................................................................................
P23_kr_hb2     ........................................................................................................................
P24_kr_mh1     ........................................................................................................................
P24_kr_mh2     ........................................................................................................................
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p25_kr_tb2     ........................................................................................................................
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P27_kr_so1     ........................................................................................................................
P27_kr_so2     ........................................................................................................................
P27_kr_so3     ........................................................................................................................
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P27_kr_so5     ........................................................................................................................
P27_kr_so6     ........................................................................................................................
P28_kr_il1     ........................................................................................................................
P29_kr_mj1     ........................................................................................................................
P29_kr_mj2     ........................................................................................................................
P30_kr_dk1     ........................................................................................................................
P31_kr_jr1     ........................................................................................................................
P32_kr_jr2     ........................................................................................................................
O1_jp_rb1      ........................................................................................................................
O2_jp_hk1      ........................................................................................................................
O2_jp_hk2      ........................................................................................................................
O2_jp_hk3      ........................................................................................................................
O2_jp_hk4      ........................................................................................................................
J1_jp_hn1      ........................................................................................................................
J1_jp_hn2      ........................................................................................................................
J2_jp_ky1      ........................................................................................................................
J3_jp_jp1      ........................................................................................................................
B1_cn_bj1      ........................................................................................................................
B2_uk_1        ........................................................................................................................
AMP_cn_1       ........................A...................................................................C.....C.....................
SUF_kr_hl1     ........................A.........................................................................C...G.................
SUF_kr_hl2     ........................A.........................................................................C...G.................
```

Appendix 2. (Continued).

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                                                                                                                                    1080
A1_kr_gr1      ATTCTCAATGGATCTCGGAGGGATTTGCAGCTATTGCGGAAATTCCATTTTCTATGCGATTAATATCTTCCCTAGAAGGAAAAGAAGTAAAAAAATACCACAATTTACGATCAATTCATT
A1_kr_gr2      ........................................................................................................................
A2_kr_hl1      ........................................................................................................................
A2_kr_hl2      ........................................................................................................................
A2_kr_hl3      ........................................................................................................................
A2_kr_hl4      ........................................................................................................................
A3_kr_hl5      ........................................................................................................................
A3_kr_hl6      ........................................................................................................................
A3_kr_hl7      ........................................................................................................................
A3_kr_hl8      ........................................................................................................................
A4_kr_hl9      ........................................................................................................................
A5_kr_hl10     ........................................................................................................................
A5_kr_hl11     ........................................................................................................................
A5_kr_hl12     ........................................................................................................................
A5_kr_hl13     ........................................................................................................................
A5_kr_hl14     ........................................................................................................................
A7_mn_1        ........................................................................................................................
A8_mn_2        ........................................................................................................................
M1_rs_kb1      ........................................................................................................................
M2_rs_kh1      ........................................................................................................................
M2_rs_kh2      ........................................................................................................................
M2_rs_kh3      ........................................................................................................................
M3_rs_kh4      ........................................................................................................................
M3_rs_kh5      ........................................................................................................................
M3_rs_kh6      ........................................................................................C...............................
M3_rs_kh7      ........................................................................................C...............................
M3_rs_kh8      ........................................................................................................................
M3_rs_kh9      ........................................................................................C...............................
M3_rs_kh10     ........................................................................................C...............................
M3_rs_kh11     ........................................................................................C...............................
M3_rs_kh12     ........................................................................................C...............................
M3_rs_kh13     ........................................................................................C...............................
M3_rs_kh14     ........................................................................................C...............................
M3_rs_kh15     ........................................................................................................................
M3_rs_kh16     ........................................................................................................................
M3_rs_kh17     ........................................................................................................................
M3_rs_kh18     ........................................................................................C...............................
M3_rs_kh19     ........................................................................................................................
M3_rs_kh20     ........................................................................................C...............................
M3_rs_kh21     ........................................................................................................................
M3_rs_kh22     ........................................................................................................................
M3_rs_kh23     ........................................................................................C...............................
M3_rs_kh24     ........................................................................................................................
M3_rs_kh25     ........................................................................................................................
M3_rs_kh26     ........................................................................................C...............................
M3_rs_kh27     ........................................................................................................................
M3_rs_kh28     ........................................................................................................................
M3_rs_kh29     ........................................................................................................................
M3_rs_kh30     ........................................................................................C...............................
M3_rs_kh31     ........................................................................................................................
M4_rs_kh32     ........................................................................................................................
M5_rs_ot1      ........................................................................................C...............................
M6_rs_ri1      .........................C..............................................................C...............................
M6_rs_ri2      ........................................................................................................................
M7_cn_hj1      .......................................................................................G................................
M8_cn_hj3      ........................................................................................................................
M8_cn_hj2      ........................................................................................................................
M8_cn_hj4      ........................................................................................................................
M9_cn_hj5      ........................................................................................................................
M10_cn_nm1     ........................................................................................................................
M11_cn_ul1     ........................................................................................................................
M12_cn_sb1     ........................................................................................................................
M12_cn_sb2     ........................................................................................................................
M13_kr_od1     ........................................................................................................................
M14_kr_jm1     ........................................................................................C...............................
M14_kr_jm2     ........................................................................................C...............................
M14_kr_jm3     ........................................................................................C...............................
M15_kr_dg1     .......................................................................................G................................
M16_kr_dr1     ........................................................................................................................
M17_kr_sw1     ........................................................................................................................
M17_kr_sw2     ........................................................................................................................
M18_kr_hg1     ........................................................................................................................
M19_kr_gy1     ........................................................................................................................
M20_kr_nh1     ........................................................................................C...............................
M20_kr_nh2     ........................................................................................C...............................
M21_kr_gu1     ........................................................................................................................
M22_kr_mp1     ........................................................................................................................
M23_kr_bc1     ........................................................................................................................
M24_kr_os1     ........................................................................................................................
M25_kr_os2     ........................................................................................................................
M25_kr_os3     ........................................................................................C...............................
M25_kr_os4     ........................................................................................................................
M25_kr_os5     ........................................................................................................................
M26_kr_sn1     ........................................................................................................................
M27_kr_gn1     ........................................................................................................................
M27_kr_gn2     ........................................................................................................................
M28_kr_bs1     ........................................................................................C...............................
M28_kr_bs2     ........................................................................................................................
M28_kr_bs3     ........................................................................................C...............................
M29_kr_jn1     ........................................................................................................................
M30_kr_bl1     ........................................................................................................................
M30_kr_bl2     ........................................................................................C...............................
M31_kr_jl1     ........................................................................................C...............................
M31_kr_jl2     ........................................................................................................................
M32_kr_mt1     ........................................................................................................................
M33_kr_md1     ........................................................................................................................
M33_kr_md2     ........................................................................................................................
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Appendix 2. (Continued).

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                                                                                                                                   1080
A1_kr_gr1      ATTCTCAATGGATCTCGGAGGGATTTGCAGCTATTGCGGAAATTCCATTTTCTATGCGATTAATATCTTCCCTAGAAGGAAAAGAAGTAAAAAAATACCACAATTTACGATCAATTCATT
M34_kr_dn1     ........................................................................................................................
M34_kr_dn2     ........................................................................................................................
M35_kr_sm1     ........................................................................................................................
M35_kr_sm2     ........................................................................................................................
P1_rs_ms1      ........................................................................................................................
P1_rs_ms2      ........................................................................................................................
P1_rs_ms3      .........................................................A..............................................................
P1_rs_ms4      ........................................................................................................................
P2_rs_nk1      ........................................................................................................................
P2_rs_nk2      ........................................................................................................................
P3_rs_pr1      ........................................................................................................................
P4_rs_pr2      ........................................................................................................................
P4_rs_pr3      .........................C..............................................................C...............................
P5_rs_rc1      ........................................................................................C...............................
P5_rs_rc2      ........................................................................................................................
P5_rs_rc3      ........................................................................................................................
P6_rs_rc4      ........................................................................................C...............................
P6_rs_rc5      ........................................................................................C...............................
P6_rs_rc6      ........................................................................................C...............................
P6_rs_rc7      ........................................................................................C...............................
P6_rs_rc8      ........................................................................................................................
P7_rs_us1      ........................................................................................................................
P7_rs_us2      ........................................................................................................................
P8_rs_pr4      ........................................................................................................................
P9_rs_pr5      ........................................................................................C...............................
P10_cn_jl1     ........................................................................................................................
P10_cn_jl2     ........................................................................................................................
P11_cn_jl3     ........................................................................................................................
P11_cn_jl4     ........................................................................................................................
P12_cn_sn1     ........................................................................................................................
P12_cn_sn2     ........................................................................................................................
P13_cn_mc1     ........................................................................................................................
P13_cn_mc2     ........................................................................................................................
P14_kr_hw1     ........................................................................................................................
P14_kr_hw2     ........................................................................................................................
P15_kr_dm1     ........................................................................................................................
P15_kr_dm2     ........................................................................................................................
P15_kr_dm3     ........................................................................................................................
P16_kr_sk1     ........................................................................................................................
P16_kr_sk2     ........................................................................................................................
P16_kr_sk3     ........................................................................................................................
P16_kr_sk4     ........................................................................................................................
P16_kr_sk5     ........................................................................................................................
P16_kr_sk6     ........................................................................................................................
P16_kr_sk7     ........................................................................................................................
P16_kr_sk8     ........................................................................................................................
P17_kr_sh1     ........................................................................................................................
P18_kr_gb1     ........................................................................................................................
P19_kr_gw1     ........................................................................................................................
P19_kr_gw2     ........................................................................................................................
P19_kr_gw3     ........................................................................................................................
P20_kr_ck1     ........................................................................................................................
P20_kr_ck2     ........................................................................................................................
P21_kr_hc1     ........................................................................................................................
P22_kr_hb1     ........................................................................................................................
P23_kr_hb2     ........................................................................................................................
P24_kr_mh1     ........................................................................................................................
P24_kr_mh2     ........................................................................................................................
p25_kr_tb1     ........................................................................................................................
p25_kr_tb2     ........................................................................................................................
P26_kr_tb3     ........................................................................................................................
P27_kr_so1     ........................................................................................................................
P27_kr_so2     ........................................................................................................................
P27_kr_so3     ........................................................................................................................
P27_kr_so4     ........................................................................................................................
P27_kr_so5     ........................................................................................................................
P27_kr_so6     ........................................................................................................................
P28_kr_il1     ........................................................................................................................
P29_kr_mj1     ........................................................................................................................
P29_kr_mj2     ........................................................................................................................
P30_kr_dk1     ........................................................................................................................
P31_kr_jr1     ........................................................................................................................
P32_kr_jr2     ........................................................................................................................
O1_jp_rb1      ........................................................................................................................
O2_jp_hk1      ........................................................................................................................
O2_jp_hk2      ........................................................................................................................
O2_jp_hk3      ........................................................................................................................
O2_jp_hk4      ........................................................................................................................
J1_jp_hn1      ........................................................................................................................
J1_jp_hn2      ........................................................................................................................
J2_jp_ky1      ........................................................................................C...............................
J3_jp_jp1      ........................................................................................................................
B1_cn_bj1      ........................................................................................C...............................
B2_uk_1        ........................................................................................C...............................
AMP_cn_1       ..................G.........................................................................C...........................
SUF_kr_hl1     ........A.......A.G.....................................................................................................
SUF_kr_hl2     ........A.......A.G.....................................................................................................
```

Appendix 2. (Continued).

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                                                                                                                                   1200
A1_kr_gr1      CCATATTTCCTTTTTTAGAGGACAAATTTTCACGTTTAAATTATGTGTTAGATATATTGATACCTCACCCTATCCATTTTGAAATCTTGGTTCAAATGATTCGTTCCTGGGTAAAAGATA
A1_kr_gr2      ........................................................................................................................
A2_kr_hl1      ........................................................................................................................
A2_kr_hl2      ........................................................................................................................
A2_kr_hl3      ........................................................................................................................
A2_kr_hl4      ........................................................................................................................
A3_kr_hl5      ........................................................................................................................
A3_kr_hl6      ........................................................................................................................
A3_kr_hl7      ........................................................................................................................
A3_kr_hl8      ........................................................................................................................
A4_kr_hl9      ........................................................................................................................
A5_kr_hl10     ........................................................................................................................
A5_kr_hl11     ........................................................................................................................
A5_kr_hl12     ........................................................................................................................
A5_kr_hl13     ........................................................................................................................
A5_kr_hl14     ........................................................................................................................
A7_mn_1        ........................................................................................................................
A8_mn_2        ........................................................................................................................
M1_rs_kb1      ........................................................................................................................
M2_rs_kh1      ........................................................................................................................
M2_rs_kh2      ........................................................................................................................
M2_rs_kh3      ........................................................................................................................
M3_rs_kh4      ........................................................................................................................
M3_rs_kh5      ........................................................................................................................
M3_rs_kh6      ........................................................................................................................
M3_rs_kh7      ........................................................................................................................
M3_rs_kh8      ........................................................................................................................
M3_rs_kh9      ........................................................................................................................
M3_rs_kh10     ........................................................................................................................
M3_rs_kh11     ........................................................................................................................
M3_rs_kh12     ........................................................................................................................
M3_rs_kh13     ........................................................................................................................
M3_rs_kh14     ........................................................................................................................
M3_rs_kh15     ........................................................................................................................
M3_rs_kh16     ........................................................................................................................
M3_rs_kh17     ........................................................................................................................
M3_rs_kh18     ........................................................................................................................
M3_rs_kh19     ........................................................................................................................
M3_rs_kh20     ........................................................................................................................
M3_rs_kh21     ........................................................................................................................
M3_rs_kh22     ........................................................................................................................
M3_rs_kh23     ........................................................................................................................
M3_rs_kh24     ........................................................................................................................
M3_rs_kh25     ........................................................................................................................
M3_rs_kh26     ........................................................................................................................
M3_rs_kh27     ........................................................................................................................
M3_rs_kh28     ........................................................................................................................
M3_rs_kh29     ........................................................................................................................
M3_rs_kh30     ........................................................................................................................
M3_rs_kh31     ........................................................................................................................
M4_rs_kh32     ........................................................................................................................
M5_rs_ot1      ........................................................................................................................
M6_rs_ri1      ....................................................G...................................................................
M6_rs_ri2      ........................................................................................................................
M7_cn_hj1      ........................................................................................................................
M8_cn_hj2      ........................................................................................................................
M8_cn_hj3      ........................................................................................................................
M8_cn_hj4      ........................................................................................................................
M9_cn_hj5      ........................................................................................................................
M10_cn_nm1     ........................................................................................................................
M11_cn_ul1     ........................................................................................................................
M12_cn_sb1     ........................................................................................................................
M12_cn_sb2     ........................................................................................................................
M13_kr_od1     ........................................................................................................................
M14_kr_jm1     ........................................................................................................................
M14_kr_jm2     ........................................................................................................................
M14_kr_jm3     ........................................................................................................................
M15_kr_dg1     ........................................................................................................................
M16_kr_dr1     ........................................................................................................................
M17_kr_sw1     ........................................................................................................................
M17_kr_sw2     ........................................................................................................................
M18_kr_hg1     ........................................................................................................................
M19_kr_gy1     ........................................................................................................................
M20_kr_nh1     ........................................................................................................................
M20_kr_nh2     ........................................................................................................................
M21_kr_gu1     ........................................................................................................................
M22_kr_mp1     ........................................................................................................................
M23_kr_bc1     ........................................................................................................................
M24_kr_os1     ........................................................................................................................
M25_kr_os2     ........................................................................................................................
M25_kr_os3     ....................................................G...................................................................
M25_kr_os4     ........................................................................................................................
M25_kr_os5     ........................................................................................................................
M26_kr_sn1     ........................................................................................................................
M27_kr_gn1     ........................................................................................................................
M27_kr_gn2     ........................................................................................................................
M28_kr_bs1     ........................................................................................................................
M28_kr_bs2     ........................................................................................................................
M28_kr_bs3     ........................................................................................................................
M29_kr_jn1     ........................................................................................................................
M30_kr_bl1     ........................................................................................................................
M30_kr_bl2     ........................................................................................................................
M31_kr_jl1     ........................................................................................................................
M31_kr_jl2     ........................................................................................................................
M32_kr_mt1     ........................................................................................................................
M33_kr_md1     ........................................................................................................................
M33_kr_md2     ........................................................................................................................
```

Appendix 2. (Continued).

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                                                                                                                                   1200
A1_kr_gr1      CCATATTTCCTTTTTTAGAGGACAAATTTTCACGTTTAAATTATGTGTTAGATATATTGATACCTCACCCTATCCATTTTGAAATCTTGGTTCAAATGATTCGTTCCTGGGTAAAAGATA
M34_kr_dn1     ........................................................................................................................
M34_kr_dn2     ........................................................................................................................
M35_kr_sm1     ........................................................................................................................
M35_kr_sm2     ........................................................................................................................
P1_rs_ms1      ........................................................................................................................
P1_rs_ms2      ........................................................................................................................
P1_rs_ms3      ........................................................................................................................
P1_rs_ms4      ........................................................................................................................
P2_rs_nk1      ........................................................................................................................
P2_rs_nk2      ........................................................................................................................
P3_rs_pr1      ........................................................................................................................
P4_rs_pr2      ........................................................................................................................
P4_rs_pr3      ....................................................G...................................................................
P5_rs_rc1      ........................................................................................................................
P5_rs_rc2      ........................................................................................................................
P5_rs_rc3      ........................................................................................................................
P6_rs_rc4      ........................................................................................................................
P6_rs_rc5      ........................................................................................................................
P6_rs_rc6      ........................................................................................................................
P6_rs_rc7      ........................................................................................................................
P6_rs_rc8      ........................................................................................................................
P7_rs_us1      ........................................................................................................................
P7_rs_us2      ........................................................................................................................
P8_rs_pr4      ........................................................................................................................
P9_rs_pr5      ........................................................................................................................
P10_cn_jl1     ........................................................................................................................
P10_cn_jl2     ........................................................................................................................
P11_cn_jl3     ........................................................................................................................
P11_cn_jl4     ........................................................................................................................
P12_cn_sn1     ........................................................................................................................
P12_cn_sn2     ........................................................................................................................
P13_cn_mc1     ........................................................................................................................
P13_cn_mc2     ........................................................................................................................
P14_kr_hw1     ........................................................................................................................
P14_kr_hw2     ........................................................................................................................
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P16_kr_sk6     ........................................................................................................................
P16_kr_sk7     ........................................................................................................................
P16_kr_sk8     ........................................................................................................................
P17_kr_sh1     ........................................................................................................................
P18_kr_gb1     ........................................................................................................................
P19_kr_gw1     ........................................................................................................................
P19_kr_gw2     ........................................................................................................................
P19_kr_gw3     ........................................................................................................................
P20_kr_ck1     ........................................................................................................................
P20_kr_ck2     ........................................................................................................................
P21_kr_hc1     ........................................................................................................................
P22_kr_hb1     ........................................................................................................................
P23_kr_hb2     ........................................................................................................................
P24_kr_mh1     ........................................................................................................................
P24_kr_mh2     ........................................................................................................................
p25_kr_tb1     ........................................................................................................................
p25_kr_tb2     ........................................................................................................................
P26_kr_tb3     ........................................................................................................................
P27_kr_so1     ........................................................................................................................
P27_kr_so2     .........................................................................................................................
P27_kr_so3     ........................................................................................................................
P27_kr_so4     ........................................................................................................................
P27_kr_so5     ........................................................................................................................
P27_kr_so6     ........................................................................................................................
P28_kr_il1     ........................................................................................................................
P29_kr_mj1     ........................................................................................................................
P29_kr_mj2     ........................................................................................................................
P30_kr_dk1     ........................................................................................................................
P31_kr_jr1     ........................................................................................................................
P32_kr_jr2     ........................................................................................................................
O1_jp_rb1      ........................................................................................................................
O2_jp_hk1      ........................................................................................................................
O2_jp_hk2      ........................................................................................................................
O2_jp_hk3      ........................................................................................................................
O2_jp_hk4      ........................................................................................................................
J1_jp_hn1      ........................................................................................................................
J1_jp_hn2      ........................................................................................................................
J2_jp_ky1      ........................................................................................................................
J3_jp_jp1      ........................................................................................................................
B1_cn_bj1      ........................................................................................................................
B2_uk_1        .....................................C..................................................................................
AMP_cn_1       ........................................................................................................................
SUF_kr_hl1     ........................................................................................................................
SUF_kr_hl2     ........................................................................................................................
```

Appendix 2. (Continued).

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                                                                                                                                   1320
A1_kr_gr1      TTTCCTGTTTGCATTTATTGCGATTCTTTCTTTATGAGTATTGTAATAGAGTTATTACTCTAAAAAGGTCTGTTTCAAAAAACAAGAATCAAAGATTCTTATTGTTCCTATATAATTCCT
A1_kr_gr2      ........................................................................................................................
A2_kr_hl1      ........................................................................................................................
A2_kr_hl2      ........................................................................................................................
A2_kr_hl3      ........................................................................................................................
A2_kr_hl4      ........................................................................................................................
A3_kr_hl5      ........................................................................................................................
A3_kr_hl6      ........................................................................................................................
A3_kr_hl7      ........................................................................................................................
A3_kr_hl8      ........................................................................................................................
A4_kr_hl9      ........................................................................................................................
A5_kr_hl10     ........................................................................................................................
A5_kr_hl11     ........................................................................................................................
A5_kr_hl12     ........................................................................................................................
A5_kr_hl13     ........................................................................................................................
A5_kr_hl14     ................C.......................................................................................................
A7_mn_1        ........................................................................................................................
A8_mn_2        ........................................................................................................................
M1_rs_kb1      ........................................................................................................................
M2_rs_kh1      ........................................................................................................................
M2_rs_kh2      ........................................................................................................................
M2_rs_kh3      ........................................................................................................................
M3_rs_kh4      ........................................................................................................................
M3_rs_kh5      ........................................................................................................................
M3_rs_kh6      ........................................................................................................................
M3_rs_kh7      ........................................................................................................................
M3_rs_kh8      ........................................................................................................................
M3_rs_kh9      ........................................................................................................................
M3_rs_kh10     ........................................................................................................................
M3_rs_kh11     ........................................................................................................................
M3_rs_kh12     ........................................................................................................................
M3_rs_kh13     ........................................................................................................................
M3_rs_kh14     ........................................................................................................................
M3_rs_kh15     ........................................................................................................................
M3_rs_kh16     ........................................................................................................................
M3_rs_kh17     ........................................................................................................................
M3_rs_kh18     ........................................................................................................................
M3_rs_kh19     ........................................................................................................................
M3_rs_kh20     ........................................................................................................................
M3_rs_kh21     ........................................................................................................................
M3_rs_kh22     ........................................................................................................................
M3_rs_kh23     ........................................................................................................................
M3_rs_kh24     ........................................................................................................................
M3_rs_kh25     ........................................................................................................................
M3_rs_kh26     ........................................................................................................................
M3_rs_kh27     ........................................................................................................................
M3_rs_kh28     ........................................................................................................................
M3_rs_kh29     ........................................................................................................................
M3_rs_kh30     ........................................................................................................................
M3_rs_kh31     ........................................................................................................................
M4_rs_kh32     ........................................................................................................................
M5_rs_ot1      ........................................................................................................................
M6_rs_ri1      ........................................................................................................................
M6_rs_ri2      ................C.......................................................................................................
M7_cn_hj1      ........................................................................................................................
M8_cn_hj2      ................C.......................................................................................................
M8_cn_hj3      ........................................................................................................................
M8_cn_hj4      ........................................................................................................................
M9_cn_hj5      ........................................................................................................................
M10_cn_nm1     ........................................................................................................................
M11_cn_ul1     ........................................................................................................................
M12_cn_sb1     ........................................................................................................................
M12_cn_sb2     ........................................................................................................................
M13_kr_od1     ........................................................................................................................
M14_kr_jm1     ........................................................................................................................
M14_kr_jm2     ........................................................................................................................
M14_kr_jm3     ........................................................................................................................
M15_kr_dg1     ........................................................................................................................
M16_kr_dr1     ........................................................................................................................
M17_kr_sw1     .....................A..................................................................................................
M17_kr_sw2     .....................A..................................................................................................
M18_kr_hg1     ........................................................................................................................
M19_kr_gy1     ........................................................................................................................
M20_kr_nh1     ........................................................................................................................
M20_kr_nh2     ........................................................................................................................
M21_kr_gu1     ........................................................................................................................
M22_kr_mp1     ........................................................................................................................
M23_kr_bc1     ........................................................................................................................
M24_kr_os1     ........................................................................................................................
M25_kr_os2     ........................................................................................................................
M25_kr_os3     ........................................................................................................................
M25_kr_os4     ........................................................................................................................
M25_kr_os5     ........................................................................................................................
M26_kr_sn1     ........................................................................................................................
M27_kr_gn1     ................C.......................................................................................................
M27_kr_gn2     ................C.......................................................................................................
M28_kr_bs1     ........................................................................................................................
M28_kr_bs2     ........................................................................................................................
M28_kr_bs3     ........................................................................................................................
M29_kr_jn1     ........................................................................................................................
M30_kr_bl1     ........................................................................................................................
M30_kr_bl2     ........................................................................................................................
M31_kr_jl1     ........................................................................................................................
M31_kr_jl2     ........................................................................................................................
M32_kr_mt1     ........................................................................................................................
M33_kr_md1     ........................................................................................................................
M33_kr_md2     ........................................................................................................................
```

Appendix 2. (Continued).

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                                                                                                                                   1320
A1_kr_gr1      TTTCCTGTTTGCATTTATTGCGATTCTTTCTTTATGAGTATTGTAATAGAGTTATTACTCTAAAAAGGTCTGTTTCAAAAAACAAGAATCAAAGATTCTTATTGTTCCTATATAATTCCT
M34_kr_dn1     ........................................................................................................................
M34_kr_dn2     ........................................................................................................................
M35_kr_sm1     ........................................................................................................................
M35_kr_sm2     ........................................................................................................................
P1_rs_ms1      ........................................................................................................................
P1_rs_ms2      ........................................................................................................................
P1_rs_ms3      ........................................................................................................................
P1_rs_ms4      ........................................................................................................................
P2_rs_nk1      ........................................................................................................................
P2_rs_nk2      ........................................................................................................................
P3_rs_pr1      ................C.......................................................................................................
P4_rs_pr2      ................C.......................................................................................................
P4_rs_pr3      ........................................................................................................................
P5_rs_rc1      ........................................................................................................................
P5_rs_rc2      ........................................................................................................................
P5_rs_rc3      ........................................................................................................................
P6_rs_rc4      ........................................................................................................................
P6_rs_rc5      ........................................................................................................................
P6_rs_rc6      ........................................................................................................................
P6_rs_rc7      ........................................................................................................................
P6_rs_rc8      ........................................................................................................................
P7_rs_us1      ........................................................................................................................
P7_rs_us2      ........................................................................................................................
P8_rs_pr4      ................C.......................................................................................................
P9_rs_pr5      ........................................................................................................................
P10_cn_jl1     ........................................................................................................................
P10_cn_jl2     ........................................................................................................................
P11_cn_jl3     ........................................................................................................................
P11_cn_jl4     ........................................................................................................................
P12_cn_sn1     ........................................................................................................................
P12_cn_sn2     ........................................................................................................................
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P13_cn_mc2     ........................................................................................................................
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P14_kr_hw2     ........................................................................................................................
P15_kr_dm1     ........................................................................................................................
P15_kr_dm2     ........................................................................................................................
P15_kr_dm3     ........................................................................................................................
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P16_kr_sk8     ........................................................................................................................
P17_kr_sh1     ........................................................................................................................
P18_kr_gb1     ........................................................................................................................
P19_kr_gw1     ........................................................................................................................
P19_kr_gw2     ........................................................................................................................
P19_kr_gw3     ................C.......................................................................................................
P20_kr_ck1     ........................................................................................................................
P20_kr_ck2     ........................................................................................................................
P21_kr_hc1     ........................................................................................................................
P22_kr_hb1     ........................................................................................................................
P23_kr_hb2     ........................................................................................................................
P24_kr_mh1     ........................................................................................................................
P24_kr_mh2     ........................................................................................................................
p25_kr_tb1     ........................................................................................................................
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P27_kr_so2     ........................................................................................................................
P27_kr_so3     ........................................................................................................................
P27_kr_so4     ........................................................................................................................
P27_kr_so5     ........................................................................................................................
P27_kr_so6     ........................................................................................................................
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P29_kr_mj1     ........................................................................................................................
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P30_kr_dk1     ........................................................................................................................
P31_kr_jr1     ........................................................................................................................
P32_kr_jr2     ........................................................................................................................
O1_jp_rb1      ........................................................................................................................
O2_jp_hk1      ........................................................................................................................
O2_jp_hk2      ........................................................................................................................
O2_jp_hk3      ........................................................................................................................
O2_jp_hk4      ........................................................................................................................
J1_jp_hn1      ........................................................................................................................
J1_jp_hn2      ........................................................................................................................
J2_jp_ky1      ........................................................................................................................
J3_jp_jp1      ........................................................................................................................
B1_cn_bj1      .........................................................................................A..............................
B2_uk_1        ........................................................................................................................
AMP_cn_1       ..................................................................................T.....................................
SUF_kr_hl1     ........................................................................................................................
SUF_kr_hl2     ........................................................................................................................
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Appendix 2. (Continued).

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                                                                                                                                   1440
A1_kr_gr1      ATGTGTGTGAATGCGAATCCATCTTCGTTTTTATCCGCAACCAATCCTCTAATTTACGATCACCATCTTACGGAGCCTTTCTTGCACGAATCTATTTCTACCTAAAGTTAGAACAGTTTT
A1_kr_gr2      ........................................................................................................................
A2_kr_hl1      ........................................................................................................................
A2_kr_hl2      ........................................................................................................................
A2_kr_hl3      ........................................................................................................................
A2_kr_hl4      .......................G................................................................................................
A3_kr_hl5      ........................................................................................................................
A3_kr_hl6      ........................................................................................................................
A3_kr_hl7      .......................G................................................................................................
A3_kr_hl8      .......................G................................................................................................
A4_kr_hl9      ........................................................................................................................
A5_kr_hl10     ........................................................................................................................
A5_kr_hl11     ........................................................................................................................
A5_kr_hl12     ........................................................................................................................
A5_kr_hl13     ........................................................................................................................
A5_kr_hl14     ........................................................................................................................
A7_mn_1        ........................................................................................................................
A8_mn_2        ........................................................................................................................
M1_rs_kb1      ........................................................................................................................
M2_rs_kh1      ........................................................................................................................
M2_rs_kh2      ........................................................................................................................
M2_rs_kh3      ........................................................................................................................
M3_rs_kh4      ........................................................................................................................
M3_rs_kh5      ........................................................................................................................
M3_rs_kh6      ......................................................................................................G.................
M3_rs_kh7      ......................................................................................................G.................
M3_rs_kh8      ........................................................................................................................
M3_rs_kh9      ......................................................................................................G.................
M3_rs_kh10     ......................................................................................................G.................
M3_rs_kh11     ......................................................................................................G.................
M3_rs_kh12     ......................................................................................................G.................
M3_rs_kh13     ......................................................................................................G.................
M3_rs_kh14     ......................................................................................................G.................
M3_rs_kh15     ........................................................................................................................
M3_rs_kh16     ........................................................................................................................
M3_rs_kh17     ........................................................................................................................
M3_rs_kh18     ......................................................................................................G.................
M3_rs_kh19     ........................................................................................................................
M3_rs_kh20     ......................................................................................................G.................
M3_rs_kh21     ........................................................................................................................
M3_rs_kh22     ........................................................................................................................
M3_rs_kh23     ......................................................................................................G.................
M3_rs_kh24     ........................................................................................................................
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M3_rs_kh26     ......................................................................................................G.................
M3_rs_kh27     ........................................................................................................................
M3_rs_kh28     ........................................................................................................................
M3_rs_kh29     ........................................................................................................................
M3_rs_kh30     ......................................................................................................G.................
M3_rs_kh31     ........................................................................................................................
M4_rs_kh32     ........................................................................................................................
M5_rs_ot1      ........................................................................................................................
M6_rs_ri1      ........................................................................................................................
M6_rs_ri2      ........................................................................................................................
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M8_cn_hj2      ........................................................................................................................
M8_cn_hj3      ........................................................................................................................
M8_cn_hj4      ........................................................................................................................
M9_cn_hj5      ........................................................................................................................
M10_cn_nm1     ........................................................................................................................
M11_cn_ul1     ........................................................................................................................
M12_cn_sb1     ........................................................................................................................
M12_cn_sb2     ........................................................................................................................
M13_kr_od1     ........................................................................................................................
M14_kr_jm1     ......................................................................................................G.................
M14_kr_jm2     ......................................................................................................G.................
M14_kr_jm3     ......................................................................................................G.................
M15_kr_dg1     ........................................................................................................................
M16_kr_dr1     ........................................................................................................................
M17_kr_sw1     ........................................................................................................................
M17_kr_sw2     ........................................................................................................................
M18_kr_hg1     ........................................................................................................................
M19_kr_gy1     ........................................................................................................................
M20_kr_nh1     ........................................................................................................................
M20_kr_nh2     ........................................................................................................................
M21_kr_gu1     ........................................................................................................................
M22_kr_mp1     ........................................................................................................................
M23_kr_bc1     ........................................................................................................................
M24_kr_os1     ........................................................................................................................
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M25_kr_os3     ........................................................................................................................
M25_kr_os4     ........................................................................................................................
M25_kr_os5     ........................................................................................................................
M26_kr_sn1     ........................................................................................................................
M27_kr_gn1     ........................................................................................................................
M27_kr_gn2     ........................................................................................................................
M28_kr_bs1     ..................................................C.....................................................................
M28_kr_bs2     ........................................................................................................................
M28_kr_bs3     ..................................................C.....................................................................
M29_kr_jn1     ........................................................................................................................
M30_kr_bl1     ........................................................................................................................
M30_kr_bl2     ........................................................................................................................
M31_kr_jl1     ........................................................................................................................
M31_kr_jl2     ........................................................................................................................
M32_kr_mt1     ........................................................................................................................
M33_kr_md1     ........................................................................................................................
M33_kr_md2     ........................................................................................................................
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Appendix 2. (Continued).

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                                                                                                                                  1440
A1_kr_gr1      ATGTGTGTGAATGCGAATCCATCTTCGTTTTTATCCGCAACCAATCCTCTAATTTACGATCACCATCTTACGGAGCCTTTCTTGCACGAATCTATTTCTACCTAAAGTTAGAACAGTTTT
M34_kr_dn1     ........................................................................................................................
M34_kr_dn2     ........................................................................................................................
M35_kr_sm1     ........................................................................................................................
M35_kr_sm2     ........................................................................................................................
P1_rs_ms1      ........................................................................................................................
P1_rs_ms2      ........................................................................................................................
P1_rs_ms3      ........................................................................................................................
P1_rs_ms4      ........................................................................................................................
P2_rs_nk1      ........................................................................................................................
P2_rs_nk2      ........................................................................................................................
P3_rs_pr1      ........................................................................................................................
P4_rs_pr2      ........................................................................................................................
P4_rs_pr3      ........................................................................................................................
P5_rs_rc1      ........................................................................................................................
P5_rs_rc2      ........................................................................................................................
P5_rs_rc3      ........................................................................................................................
P6_rs_rc4      ........................................................................................................................
P6_rs_rc5      ........................................................................................................................
P6_rs_rc6      ........................................................................................................................
P6_rs_rc7      ........................................................................................................................
P6_rs_rc8      ........................................................................................................................
P7_rs_us1      ........................................................................................................................
P7_rs_us2      ........................................................................................................................
P8_rs_pr4      ........................................................................................................................
P9_rs_pr5      ........................................................................................................................
P10_cn_jl1     ........................................................................................................................
P10_cn_jl2     ........................................................................................................................
P11_cn_jl3     ........................................................................................................................
P11_cn_jl4     ........................................................................................................................
P12_cn_sn1     ........................................................................................................................
P12_cn_sn2     ........................................................................................................................
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P16_kr_sk8     ........................................................................................................................
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P19_kr_gw1     ........................................................................................................................
P19_kr_gw2     ........................................................................................................................
P19_kr_gw3     ........................................................................................................................
P20_kr_ck1     ........................................................................................................................
P20_kr_ck2     ........................................................................................................................
P21_kr_hc1     ........................................................................................................................
P22_kr_hb1     ........................................................................................................................
P23_kr_hb2     ........................................................................................................................
P24_kr_mh1     ........................................................................................................................
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P27_kr_so4     ........................................................................................................................
P27_kr_so5     ........................................................................................................................
P27_kr_so6     ........................................................................................................................
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P29_kr_mj1     ........................................................................................................................
P29_kr_mj2     ........................................................................................................................
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P32_kr_jr2     ........................................................................................................................
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O2_jp_hk2      ........................................................................................................................
O2_jp_hk3      ........................................................................................................................
O2_jp_hk4      ........................................................................................................................
J1_jp_hn1      ........................................................................................................................
J1_jp_hn2      ........................................................................................................................
J2_jp_ky1      ........................................................................................................................
J3_jp_jp1      ........................................................................................................................
B1_cn_bj1      ........................................................................................................................
B2_uk_1        ........................................................................................................................
AMP_cn_1       ........................................................................................................................
SUF_kr_hl1     ........................................................................................................................
SUF_kr_hl2     ........................................................................................................................
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Appendix 2. (Continued).

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                                                                                                                                     1560
A1_kr_gr1      TAAAATTATGTACTAAGAATTTTCCGATTATTCTATGGTTGTTTAAGGATCTTTTTCTACATTATGTTAGGTATCAAGGAAAATGGATTCTAGTTTCAAGGGGCACATTTCTTCTGCTGA
A1_kr_gr2      ........................................................................................................................
A2_kr_hl1      ........................................................................................................................
A2_kr_hl2      ........................................................................................................................
A2_kr_hl3      ........................................................................................................................
A2_kr_hl4      ........................................................................................................................
A3_kr_hl5      ........................................................................................................................
A3_kr_hl6      ........................................................................................................................
A3_kr_hl7      ........................................................................................................................
A3_kr_hl8      ........................................................................................................................
A4_kr_hl9      ........................................................................................................................
A5_kr_hl10     ........................................................................................................................
A5_kr_hl11     ........................................................................................................................
A5_kr_hl12     ........................................................................................................................
A5_kr_hl13     ........................................................................................................................
A5_kr_hl14     ........................................................................................................................
A7_mn_1        ........................................................................................................................
A8_mn_2        ........................................................................................................................
M1_rs_kb1      ........................................................................................................................
M2_rs_kh1      ........................................................................................................................
M2_rs_kh2      ........................................................................................................................
M2_rs_kh3      ........................................................................................................................
M3_rs_kh4      ........................................................................................................................
M3_rs_kh5      ........................................................................................................................
M3_rs_kh6      ........................................................................................................................
M3_rs_kh7      ........................................................................................................................
M3_rs_kh8      ........................................................................................................................
M3_rs_kh9      ........................................................................................................................
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M3_rs_kh12     ........................................................................................................................
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M3_rs_kh16     ........................................................................................................................
M3_rs_kh17     ........................................................................................................................
M3_rs_kh18     ........................................................................................................................
M3_rs_kh19     ........................................................................................................................
M3_rs_kh20     ........................................................................................................................
M3_rs_kh21     ........................................................................................................................
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M3_rs_kh26     ........................................................................................................................
M3_rs_kh27     ........................................................................................................................
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M3_rs_kh29     ........................................................................................................................
M3_rs_kh30     ........................................................................................................................
M3_rs_kh31     ........................................................................................................................
M4_rs_kh32     ........................................................................................................................
M5_rs_ot1      ........................................................................................................................
M6_rs_ri1      ........................................................................................................................
M6_rs_ri2      ........................................................................................................................
M7_cn_hj1      ........................................................................................................................
M8_cn_hj3      ........................................................................................................................
M8_cn_hj2      ........................................................................................................................
M8_cn_hj4      ........................................................................................................................
M9_cn_hj5      ........................................................................................................................
M10_cn_nm1     ........................................................................................................................
M11_cn_ul1     ........................................................................................................................
M12_cn_sb1     ........................................................................................................................
M12_cn_sb2     ........................................................................................................................
M13_kr_od1     ........................................................................................................................
M14_kr_jm1     ........................................................................................................................
M14_kr_jm2     ........................................................................................................................
M14_kr_jm3     ........................................................................................................................
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M17_kr_sw2     ........................................................................................................................
M18_kr_hg1     ........................................................................................................................
M19_kr_gy1     ........................................................................................................................
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M20_kr_nh2     ........................................................................................................................
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M22_kr_mp1     ........................................................................................................................
M23_kr_bc1     ........................................................................................................................
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M27_kr_gn1     ........................................................................................................................
M27_kr_gn2     ........................................................................................................................
M28_kr_bs1     ........................................................................................................................
M28_kr_bs2     ........................................................................................................................
M28_kr_bs3     ........................................................................................................................
M29_kr_jn1     ........................................................................................................................
M30_kr_bl1     ........................................................................................................................
M30_kr_bl2     ........................................................................................................................
M31_kr_jl1     ........................................................................................................................
M31_kr_jl2     ........................................................................................................................
M32_kr_mt1     ........................................................................................................................
M33_kr_md1     ........................................................................................................................
M33_kr_md2     ........................................................................................................................
```

Appendix 2. (Continued).

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                                                                                                                                     1560
A1_kr_gr1      TAAAATTATGTACTAAGAATTTTCCGATTATTCTATGGTTGTTTAAGGATCTTTTTCTACATTATGTTAGGTATCAAGGAAAATGGATTCTAGTTTCAAGGGGCACATTTCTTCTGCTGA
M34_kr_dn1     ........................................................................................................................
M34_kr_dn2     ........................................................................................................................
M35_kr_sm1     ........................................................................................................................
M35_kr_sm2     ........................................................................................................................
P1_rs_ms1      ........................................................................................................................
P1_rs_ms2      ........................................................................................................................
P1_rs_ms3      ........................................................................................................................
P1_rs_ms4      ........................................................................................................................
P2_rs_nk1      ........................................................................................................................
P2_rs_nk2      ........................................................................................................................
P3_rs_pr1      ........................................................................................................................
P4_rs_pr2      ........................................................................................................................
P4_rs_pr3      ........................................................................................................................
P5_rs_rc1      ........................................................................................................................
P5_rs_rc2      ........................................................................................................................
P5_rs_rc3      ........................................................................................................................
P6_rs_rc4      ........................................................................................................................
P6_rs_rc5      ........................................................................................................................
P6_rs_rc6      ........................................................................................................................
P6_rs_rc7      ........................................................................................................................
P6_rs_rc8      ........................................................................................................................
P7_rs_us1      ........................................................................................................................
P7_rs_us2      ........................................................................................................................
P8_rs_pr4      ........................................................................................................................
P9_rs_pr5      ........................................................................................................................
P10_cn_jl1     ........................................................................................................................
P10_cn_jl2     ........................................................................................................................
P11_cn_jl3     ........................................................................................................................
P11_cn_jl4     ........................................................................................................................
P12_cn_sn1     ........................................................................................................................
P12_cn_sn2     ........................................................................................................................
P13_cn_mc1     ........................................................................................................................
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P19_kr_gw2     ........................................................................................................................
P19_kr_gw3     ........................................................................................................................
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P24_kr_mh2     ........................................................................................................................
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P27_kr_so2     ........................................................................................................................
P27_kr_so3     ........................................................................................................................
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P27_kr_so6     ........................................................................................................................
P28_kr_il1     ........................................................................................................................
P29_kr_mj1     ..................................................................................................................C.....
P29_kr_mj2     ..................................................................................................................C.....
P30_kr_dk1     ........................................................................................................................
P31_kr_jr1     ........................................................................................................................
P32_kr_jr2     ........................................................................................................................
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O2_jp_hk1      ........................................................................................................................
O2_jp_hk2      ........................................................................................................................
O2_jp_hk3      ........................................................................................................................
O2_jp_hk4      ........................................................................................................................
J1_jp_hn1      ........................................................................................................................
J1_jp_hn2      ........................................................................................................................
J2_jp_ky1      ........................................................................................................................
J3_jp_jp1      ........................................................................................................................
B1_cn_bj1      ........................................................................................................................
B2_uk_1        ........................................................................................................................
AMP_cn_1       ...................................................C......G............................................G................
SUF_kr_hl1     ...................................................C......G.........C..................................G................
SUF_kr_hl2     ...................................................C......G.........C..................................G................
```

Appendix 2. (Continued).

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                                                                                                                                  1680
A1_kr_gr1      CTAAATTGAAATATTACCTTGTCAATTTCTGTCAATGTAATTTTTCGTTATGGTTGCAACCAAGAAGAATCTATATCAATCAATCATCAAATCAGCGCATTGACTTTATGGGTTTTCTTT
A1_kr_gr2      ........................................................................................................................
A2_kr_hl1      ........................................................................................................................
A2_kr_hl2      ........................................................................................................................
A2_kr_hl3      ........................................................................................................................
A2_kr_hl4      ........................................................................................................................
A3_kr_hl5      ........................................................................................................................
A3_kr_hl6      ........................................................................................................................
A3_kr_hl7      ........................................................................................................................
A3_kr_hl8      ........................................................................................................................
A4_kr_hl9      ........................................................................................................................
A5_kr_hl10     ........................................................................................................................
A5_kr_hl11     ........................................................................................................................
A5_kr_hl12     ........................................................................................................................
A5_kr_hl13     ........................................................................................................................
A5_kr_hl14     ........................................................................................................................
A7_mn_1        ........................................................................................................................
A8_mn_2        ........................................................................................................................
M1_rs_kb1      ........................................................................................................................
M2_rs_kh1      ........................................................................................................................
M2_rs_kh2      ........................................................................................................................
M2_rs_kh3      ........................................................................................................................
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M3_rs_kh5      ........................................................................................................................
M3_rs_kh6      ........................................................................................................................
M3_rs_kh7      ........................................................................................................................
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M3_rs_kh9      ........................................................................................................................
M3_rs_kh10     ........................................................................................................................
M3_rs_kh11     ........................................................................................................................
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M3_rs_kh31     ........................................................................................................................
M4_rs_kh32     ........................................................................................................................
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M6_rs_ri1      ........................................................................................................................
M6_rs_ri2      ........................................................................................................................
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M8_cn_hj2      ........................................................................................................................
M8_cn_hj3      ........................................................................................................................
M8_cn_hj4      ........................................................................................................................
M9_cn_hj5      ........................................................................................................................
M10_cn_nm1     ........................................................................................................................
M11_cn_ul1     ........................................................................................................................
M12_cn_sb1     ........................................................................................................................
M12_cn_sb2     ........................................................................................................................
M13_kr_od1     ........................................................................................................................
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M14_kr_jm2     ........................................................................................................................
M14_kr_jm3     ........................................................................................................................
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M16_kr_dr1     ........................................................................................................................
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M18_kr_hg1     ........................................................................................................................
M19_kr_gy1     ........................................................................................................................
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M20_kr_nh2     ........................................................................................................................
M21_kr_gu1     ........................................................................................................................
M22_kr_mp1     ........................................................................................................................
M23_kr_bc1     ........................................................................................................................
M24_kr_os1     ........................................................................................................................
M25_kr_os2     ........................................................................................................................
M25_kr_os3     ........................................................................................................................
M25_kr_os4     ........................................................................................................................
M25_kr_os5     ........................................................................................................................
M26_kr_sn1     ........................................................................................................................
M27_kr_gn1     ........................................................................................................................
M27_kr_gn2     ........................................................................................................................
M28_kr_bs1     ........................................................................................................................
M28_kr_bs2     ........................................................................................................................
M28_kr_bs3     ........................................................................................................................
M29_kr_jn1     ........................................................................................................................
M30_kr_bl1     ........................................................................................................................
M30_kr_bl2     ........................................................................................................................
M31_kr_jl1     ........................................................................................................................
M31_kr_jl2     ........................................................................................................................
M32_kr_mt1     ........................................................................................................................
M33_kr_md1     ........................................................................................................................
M33_kr_md2     ........................................................................................................................
```

Appendix 2. (Continued).

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                                                                                                                                   1680
A1_kr_gr1      CTAAATTGAAATATTACCTTGTCAATTTCTGTCAATGTAATTTTTCGTTATGGTTGCAACCAAGAAGAATCTATATCAATCAATCATCAAATCAGCGCATTGACTTTATGGGTTTTCTTT
M34_kr_dn1     ........................................................................................................................
M34_kr_dn2     ........................................................................................................................
M35_kr_sm1     ........................................................................................................................
M35_kr_sm2     ........................................................................................................................
P1_rs_ms1      ........................................................................................................................
P1_rs_ms2      ........................................................................................................................
P1_rs_ms3      ........................................A...............................................................................
P1_rs_ms4      ........................................................................................................................
P2_rs_nk1      ........................................................................................................................
P2_rs_nk2      ........................................................................................................................
P3_rs_pr1      ........................................................................................................................
P4_rs_pr2      ........................................................................................................................
P4_rs_pr3      ........................................................................................................................
P5_rs_rc1      ........................................................................................................................
P5_rs_rc2      ........................................................................................................................
P5_rs_rc3      ........................................................................................................................
P6_rs_rc4      ........................................................................................................................
P6_rs_rc5      ........................................................................................................................
P6_rs_rc6      ........................................................................................................................
P6_rs_rc7      ........................................................................................................................
P6_rs_rc8      ........................................................................................................................
P7_rs_us1      ........................................................................................................................
P7_rs_us2      ........................................................................................................................
P8_rs_pr4      ........................................................................................................................
P9_rs_pr5      ........................................................................................................................
P10_cn_jl1     ........................................................................................................................
P10_cn_jl2     .......................................................................................................................
P11_cn_jl3     ........................................................................................................................
P11_cn_jl4     ........................................................................................................................
P12_cn_sn1     ........................................................................................................................
P12_cn_sn2     ........................................................................................................................
P13_cn_mc1     ........................................................................................................................
P13_cn_mc2     ........................................................................................................................
P14_kr_hw1     ........................................................................................................................
P14_kr_hw2     ........................................................................................................................
P15_kr_dm1     ........................................................................................................................
P15_kr_dm2     ........................................................................................................................
P15_kr_dm3     ........................................................................................................................
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P16_kr_sk2     ........................................................................................................................
P16_kr_sk3     ........................................................................................................................
P16_kr_sk4     ........................................................................................................................
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P16_kr_sk6     ........................................................................................................................
P16_kr_sk7     ........................................................................................................................
P16_kr_sk8     ........................................................................................................................
P17_kr_sh1     ........................................................................................................................
P18_kr_gb1     ........................................................................................................................
P19_kr_gw1     ........................................................................................................................
P19_kr_gw2     ........................................................................................................................
P19_kr_gw3     ....................................................................C...................................................
P20_kr_ck1     ........................................................................................................................
P20_kr_ck2     ........................................................................................................................
P21_kr_hc1     ........................................................................................................................
P22_kr_hb1     ........................................................................................................................
P23_kr_hb2     ........................................................................................................................
P24_kr_mh1     ........................................................................................................................
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p25_kr_tb1     ........................................................................................................................
p25_kr_tb2     ........................................................................................................................
P26_kr_tb3     ........................................................................................................................
P27_kr_so1     ........................................................................................................................
P27_kr_so2     ........................................................................................................................
P27_kr_so3     ........................................................................................................................
P27_kr_so4     ........................................................................................................................
P27_kr_so5     ........................................................................................................................
P27_kr_so6     ........................................................................................................................
P28_kr_il1     ........................................................................................................................
P29_kr_mj1     ........................................................................................................................
P29_kr_mj2     ........................................................................................................................
P30_kr_dk1     ........................................................................................................................
P31_kr_jr1     ........................................................................................................................
P32_kr_jr2     ........................................................................................................................
O1_jp_rb1      ........................................................................................................................
O2_jp_hk1      ........................................................................................................................
O2_jp_hk2      ........................................................................................................................
O2_jp_hk3      ........................................................................................................................
O2_jp_hk4      ........................................................................................................................
J1_jp_hn1      ........................................................................................................................
J1_jp_hn2      ........................................................................................................................
J2_jp_ky1      ........................................................................................................................
J3_jp_jp1      ........................................................................................................................
B1_cn_bj1      ........................................................................................................................
B2_uk_1        ........................................................................................................................
AMP_cn_1       .....................................................................................C..................................
SUF_kr_hl1     ........................................................................................................................
SUF_kr_hl2     ........................................................................................................................
```

Appendix 2. (Continued).

```
                                                                                                                   1800
A1_kr_gr1      TAAGTGGGCGGCTAAATCCGTTCGTGGTACGGAGTCAAATGTTAGAAAATTCATTCTTAATAGAGAATGGTATTAAGAAGTTTGAGACCCTAGTTCCAATTATGCCAATGGTTGGATCAT
A1_kr_gr2      ........................................................................................................................
A2_kr_hl1      ........................................................................................................................
A2_kr_hl2      ........................................................................................................................
A2_kr_hl3      ........................................................................................................................
A2_kr_hl4      ........................................................................................................................
A3_kr_hl5      ........................................................................................................................
A3_kr_hl6      ........................................................................................................................
A3_kr_hl7      ........................................................................................................................
A3_kr_hl8      ........................................................................................................................
A4_kr_hl9      ........................................................................................................................
A5_kr_hl10     ........................................................................................................................
A5_kr_hl11     ........................................................................................................................
A5_kr_hl12     ........................................................................................................................
A5_kr_hl13     ........................................................................................................................
A5_kr_hl14     ........................................................................................................................
A7_mn_1        ........................................................................................................................
A8_mn_2        ........................................................................................................................
M1_rs_kb1      ........................................................................................................................
M2_rs_kh1      ........................................................................................................................
M2_rs_kh2      ........................................................................................................................
M2_rs_kh3      ........................................................................................................................
M3_rs_kh4      ........................................................................................................................
M3_rs_kh5      ........................................................................................................................
M3_rs_kh6      ........................................................................................................................
M3_rs_kh7      ........................................................................................................................
M3_rs_kh8      ........................................................................................................................
M3_rs_kh9      ........................................................................................................................
M3_rs_kh10     ........................................................................................................................
M3_rs_kh11     ........................................................................................................................
M3_rs_kh12     ........................................................................................................................
M3_rs_kh13     ........................................................................................................................
M3_rs_kh14     ........................................................................................................................
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M3_rs_kh17     ........................................................................................................................
M3_rs_kh18     ........................................................................................................................
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M3_rs_kh22     ........................................................................................................................
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M3_rs_kh25     ........................................................................................................................
M3_rs_kh26     ........................................................................................................................
M3_rs_kh27     ........................................................................................................................
M3_rs_kh28     ........................................................................................................................
M3_rs_kh29     ........................................................................................................................
M3_rs_kh30     ........................................................................................................................
M3_rs_kh31     ........................................................................................................................
M4_rs_kh32     ........................................................................................................................
M5_rs_ot1      ........................................................................................................................
M6_rs_ri1      ........................................................................................................................
M6_rs_ri2      ........................................................................................................................
M7_cn_hj1      ........................................................................................................................
M8_cn_hj2      ........................................................................................................................
M8_cn_hj3      ........................................................................................................................
M8_cn_hj4      ........................................................................................................................
M9_cn_hj5      ........................................................................................................................
M10_cn_nm1     ........................................................................................................................
M11_cn_ul1     ........................................................................................................................
M12_cn_sb1     ........................................................................................................................
M12_cn_sb2     ........................................................................................................................
M13_kr_od1     ........................................................................................................................
M14_kr_jm1     ........................................................................................................................
M14_kr_jm2     ........................................................................................................................
M14_kr_jm3     ........................................................................................................................
M15_kr_dg1     ........................................................................................................................
M16_kr_dr1     ........................................................................................................................
M17_kr_sw1     ........................................................................................................................
M17_kr_sw2     ........................................................................................................................
M18_kr_hg1     ........................................................................................................................
M19_kr_gy1     ........................................................................................................................
M20_kr_nh1     ........................................................................................................................
M20_kr_nh2     ........................................................................................................................
M21_kr_gu1     ........................................................................................................................
M22_kr_mp1     ........................................................................................................................
M23_kr_bc1     ........................................................................................................................
M24_kr_os1     ........................................................................................................................
M25_kr_os2     ........................................................................................................................
M25_kr_os3     ........................................................................................................................
M25_kr_os4     ........................................................................................................................
M25_kr_os5     ........................................................................................................................
M26_kr_sn1     ........................................................................................................................
M27_kr_gn1     ........................................................................................................................
M27_kr_gn2     ........................................................................................................................
M28_kr_bs1     ........................................................................................................................
M28_kr_bs2     ........................................................................................................................
M28_kr_bs3     ........................................................................................................................
M29_kr_jn1     ........................................................................................................................
M30_kr_bl1     ........................................................................................................................
M30_kr_bl2     ........................................................................................................................
M31_kr_jl1     ........................................................................................................................
M31_kr_jl2     ........................................................................................................................
M32_kr_mt1     ........................................................................................................................
M33_kr_md1     ........................................................................................................................
M33_kr_md2     ........................................................................................................................
```

Appendix 2. (Continued).

```
                                                                                                                                   1800
A1_kr_gr1      TAAGTGGGCGGCTAAATCCGTTCGTGGTACGGAGTCAAATGTTAGAAAATTCATTCTTAATAGAGAATGGTATTAAGAAGTTTGAGACCCTAGTTCCAATTATGCCAATGGTTGGATCAT
M34_kr_dn1     ........................................................................................................................
M34_kr_dn2     ........................................................................................................................
M35_kr_sm1     ........................................................................................................................
M35_kr_sm2     ........................................................................................................................
P1_rs_ms1      ........................................................................................................................
P1_rs_ms2      ........................................................................................................................
P1_rs_ms3      ........................................................................................................................
P1_rs_ms4      ........................................................................................................................
P2_rs_nk1      ........................................................................................................................
P2_rs_nk2      ........................................................................................................................
P3_rs_pr1      ........................................................................................................................
P4_rs_pr2      ........................................................................................................................
P4_rs_pr3      ........................................................................................................................
P5_rs_rc1      ........................................................................................................................
P5_rs_rc2      ........................................................................................................................
P5_rs_rc3      ........................................................................................................................
P6_rs_rc4      ........................................................................................................................
P6_rs_rc5      ........................................................................................................................
P6_rs_rc6      ........................................................................................................................
P6_rs_rc7      ........................................................................................................................
P6_rs_rc8      ........................................................................................................................
P7_rs_us1      ........................................................................................................................
P7_rs_us2      ........................................................................................................................
P8_rs_pr4      ........................................................................................................................
P9_rs_pr5      ........................................................................................................................
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P10_cn_jl2     ........................................................................................................................
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P11_cn_jl4     ........................................................................................................................
P12_cn_sn1     ........................................................................................................................
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P14_kr_hw2     ........................................................................................................................
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P16_kr_sk8     ........................................................................................................................
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P19_kr_gw1     ........................................................................................................................
P19_kr_gw2     ........................................................................................................................
P19_kr_gw3     ........................................................................................................................
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P21_kr_hc1     ........................................................................................................................
P22_kr_hb1     ........................................................................................................................
P23_kr_hb2     ........................................................................................................................
P24_kr_mh1     ........................................................................................................................
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P27_kr_so5     ........................................................................................................................
P27_kr_so6     ........................................................................................................................
P28_kr_il1     ........................................................................................................................
P29_kr_mj1     ........................................................................................................................
P29_kr_mj2     ........................................................................................................................
P30_kr_dk1     ........................................................................................................................
P31_kr_jr1     ........................................................................................................................
P32_kr_jr2     ........................................................................................................................
O1_jp_rb1      ........................................................................................................................
O2_jp_hk1      ........................................................................................................................
O2_jp_hk2      ........................................................................................................................
O2_jp_hk3      ........................................................................................................................
O2_jp_hk4      ........................................................................................................................
J1_jp_hn1      ........................................................................................................................
J1_jp_hn2      ........................................................................................................................
J2_jp_ky1      ........................................................................................................................
J3_jp_jp1      ........................................................................................................................
B1_cn_bj1      ........................................................................................................................
B2_uk_1        ........................................................................................................................
AMP_cn_1       ..............................................................................................................A.CCA.....
SUF_kr_hl1     ..............................................................................................................A.........
SUF_kr_hl2     ..............................................................................................................A.........
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Appendix 2. (Continued).

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                                                                                                                                   1920
A1_kr_gr1      TGGCTAAAGCATCGGAGCGGGACTTCTTCTTTTTCCGACAACAACAACAAATCTTCGTCGTATATGGGCTTTTCCTAGTATTTCGTTATTGAGTTTAGTTATGCTTTTTTCAATGAACTT
A1_kr_gr2      ........................................................................................................................
A2_kr_hl1      ........................................................................................................................
A2_kr_hl2      ........................................................................................................................
A2_kr_hl3      ........................................................................................................................
A2_kr_hl4      ........................................................................................................................
A3_kr_hl5      ........................................................................................................................
A3_kr_hl6      ........................................................................................................................
A3_kr_hl7      ........................................................................................................................
A3_kr_hl8      ........................................................................................................................
A4_kr_hl9      ........................................................................................................................
A5_kr_hl10     ........................................................................................................................
A5_kr_hl11     ........................................................................................................................
A5_kr_hl12     ........................................................................................................................
A5_kr_hl13     ........................................................................................................................
A5_kr_hl14     ........................................................................................................................
A7_mn_1        ........................................................................................................................
A8_mn_2        ........................................................................................................................
M1_rs_kb1      ........................................................................................................................
M2_rs_kh1      ........................................................................................................................
M2_rs_kh2      ........................................................................................................................
M2_rs_kh3      ........................................................................................................................
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M6_rs_ri2      ........................................................................................................................
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M8_cn_hj2      ........................................................................................................................
M8_cn_hj3      ........................................................................................................................
M8_cn_hj4      ........................................................................................................................
M9_cn_hj5      ........................................................................................................................
M10_cn_nm1     ........................................................................................................................
M11_cn_ul1     ........................................................................................................................
M12_cn_sb1     ........................................................................................................................
M12_cn_sb2     ........................................................................................................................
M13_kr_od1     ........................................................................................................................
M14_kr_jm1     ........................................................................................................................
M14_kr_jm2     ........................................................................................................................
M14_kr_jm3     ........................................................................................................................
M15_kr_dg1     ........................................................................................................................
M16_kr_dr1     ........................................................................................................................
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M17_kr_sw2     ........................................................................................................................
M18_kr_hg1     ........................................................................................................................
M19_kr_gy1     ........................................................................................................................
M20_kr_nh1     ........................................................................................................................
M20_kr_nh2     ........................................................................................................................
M21_kr_gu1     ........................................................................................................................
M22_kr_mp1     ........................................................................................................................
M23_kr_bc1     ........................................................................................................................
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M25_kr_os2     ........................................................................................................................
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M25_kr_os4     ........................................................................................................................
M25_kr_os5     ........................................................................................................................
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M28_kr_bs2     ........................................................................................................................
M28_kr_bs3     ........................................................................................................................
M29_kr_jn1     ........................................................................................................................
M30_kr_bl1     ........................................................................................................................
M30_kr_bl2     ........................................................................................................................
M31_kr_jl1     ........................................................................................................................
M31_kr_jl2     ........................................................................................................................
M32_kr_mt1     ........................................................................................................................
M33_kr_md1     ........................................................................................................................
M33_kr_md2     ........................................................................................................................
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Appendix 2. (Continued).

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                                                                                                                                   1920
A1_kr_gr1      TGGCTAAAGCATCGGAGCGGGACTTCTTCTTTTTCCGACAACAACAACAAATCTTCGTCGTATATGGGCTTTTCCTAGTATTTCGTTATTGAGTTTAGTTATGCTTTTTTCAATGAACTT
M34_kr_dn1     ........................................................................................................................
M34_kr_dn2     ........................................................................................................................
M35_kr_sm1     ........................................................................................................................
M35_kr_sm2     ........................................................................................................................
P1_rs_ms1      ........................................................................................................................
P1_rs_ms2      ........................................................................................................................
P1_rs_ms3      ........................................................................................................................
P1_rs_ms4      ........................................................................................................................
P2_rs_nk1      ........................................................................................................................
P2_rs_nk2      ........................................................................................................................
P3_rs_pr1      ........................................................................................................................
P4_rs_pr2      ........................................................................................................................
P4_rs_pr3      ........................................................................................................................
P5_rs_rc1      ........................................................................................................................
P5_rs_rc2      ........................................................................................................................
P5_rs_rc3      ........................................................................................................................
P6_rs_rc4      ........................................................................................................................
P6_rs_rc5      ........................................................................................................................
P6_rs_rc6      ........................................................................................................................
P6_rs_rc7      ........................................................................................................................
P6_rs_rc8      ........................................................................................................................
P7_rs_us1      ........................................................................................................................
P7_rs_us2      ........................................................................................................................
P8_rs_pr4      ........................................................................................................................
P9_rs_pr5      ........................................................................................................................
P10_cn_jl1     ........................................................................................................................
P10_cn_jl2     ........................................................................................................................
P11_cn_jl3     ........................................................................................................................
P11_cn_jl4     ........................................................................................................................
P12_cn_sn1     ........................................................................................................................
P12_cn_sn2     ........................................................................................................................
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P16_kr_sk8     ........................................................................................................................
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P19_kr_gw1     ........................................................................................................................
P19_kr_gw2     ........................................................................................................................
P19_kr_gw3     ........................................................................................................................
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P20_kr_ck2     ........................................................................................................................
P21_kr_hc1     ........................................................................................................................
P22_kr_hb1     ........................................................................................................................
P23_kr_hb2     ........................................................................................................................
P28_kr_il1     ........................................................................................................................
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P24_kr_mh2     ........................................................................................................................
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p25_kr_tb2     ........................................................................................................................
P26_kr_tb3     ........................................................................................................................
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P27_kr_so2     ........................................................................................................................
P27_kr_so3     ........................................................................................................................
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P27_kr_so6     ........................................................................................................................
P29_kr_mj1     ........................................................................................................................
P29_kr_mj2     ........................................................................................................................
P30_kr_dk1     ........................................................................................................................
P31_kr_jr1     ........................................................................................................................
P32_kr_jr2     ........................................................................................................................
O1_jp_rb1      ........................................................................................................................
O2_jp_hk1      ........................................................................................................................
O2_jp_hk2      ........................................................................................................................
O2_jp_hk3      ........................................................................................................................
O2_jp_hk4      ........................................................................................................................
J1_jp_hn1      ........................................................................................................................
J1_jp_hn2      ........................................................................................................................
J2_jp_ky1      ........................................................................................................................
J3_jp_jp1      ........................................................................................................................
B1_cn_bj1      ........................................................................................................................
B2_uk_1        ........................................................................................................................
AMP_cn_1       ..............................................................................................C.........................
SUF_kr_hl1     ..............................................................................................C...................T.....
SUF_kr_hl2     ..............................................................................................C...................T.....
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Appendix 2. (Continued).

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                                                                                                                                   2040
A1_kr_gr1      GTCTATTCAACAAATAAATAGCAATTCTATCTACCAATCCGTATGGTCTTGGACCATCAATAATGATTTTTCTTTAGAGTTCGGTTACTTGGTTGATCCGCTTACTTCTATTATGTCAAT
A1_kr_gr2      ....................................................................................................................T...
A2_kr_hl1      ................................................................................................C.......................
A2_kr_hl2      ........................................................................................................................
A2_kr_hl3      ....................................................................................................................T...
A2_kr_hl4      ........................................................................................................................
A3_kr_hl5      ....................................................................................................................T...
A3_kr_hl6      ....................................................................................................................T...
A3_kr_hl7      ........................................................................................................................
A3_kr_hl8      ........................................................................................................................
A4_kr_hl9      ........................................................................................................................
A5_kr_hl10     ....................................................................................................................T...
A5_kr_hl11     ....................................................................................................................T...
A5_kr_hl12     ....................................................................................................................T...
A5_kr_hl13     ....................................................................................................................T...
A5_kr_hl14     ....................................................................................................................T...
A7_mn_1        ....................................................................................................................T...
A8_mn_2        ....................................................................................................................T...
M1_rs_kb1      ...........................................G........................................................................T...
M2_rs_kh1      ....................................................................................................................T...
M2_rs_kh2      ....................................................................................................................T...
M2_rs_kh3      ....................................................................................................................T...
M3_rs_kh4      ....................................................................................................................T...
M3_rs_kh5      ....................................................................................................................T...
M3_rs_kh6      ........................................................................................................................
M3_rs_kh7      ........................................................................................................................
M3_rs_kh8      ....................................................................................................................T...
M3_rs_kh9      ........................................................................................................................
M3_rs_kh10     ........................................................................................................................
M3_rs_kh11     ........................................................................................................................
M3_rs_kh12     ........................................................................................................................
M3_rs_kh13     ........................................................................................................................
M3_rs_kh14     ........................................................................................................................
M3_rs_kh15     ....................................................................................................................T...
M3_rs_kh16     ....................................................................................................................T...
M3_rs_kh17     ....................................................................................................................T...
M3_rs_kh18     ........................................................................................................................
M3_rs_kh19     ....................................................................................................................T...
M3_rs_kh20     ........................................................................................................................
M3_rs_kh21     ....................................................................................................................T...
M3_rs_kh22     ....................................................................................................................T...
M3_rs_kh23     ........................................................................................................................
M3_rs_kh24     ....................................................................................................................T...
M3_rs_kh25     ....................................................................................................................T...
M3_rs_kh26     ........................................................................................................................
M3_rs_kh27     ....................................................................................................................T...
M3_rs_kh28     ........................................................................................................................
M3_rs_kh29     ....................................................................................................................T...
M3_rs_kh30     ........................................................................................................................
M3_rs_kh31     ....................................................................................................................T...
M4_rs_kh32     ....................................................................................................................T...
M5_rs_ot1      ........................................................................................................................
M6_rs_ri1      ........................................................................................................................
M6_rs_ri2      ....................................................................................................................T...
M7_cn_hj1      ........................................................................................................................
M8_cn_hj2      ....................................................................................................................T...
M8_cn_hj3      ....................................................................................................................T...
M8_cn_hj4      ....................................................................................................................T...
M9_cn_hj5      ....................................................................................................................T...
M10_cn_nm1     ....................................................................................................................T...
M11_cn_ul1     ....................................................................................................................T...
M12_cn_sb1     ....................................................................................................................T...
M12_cn_sb2     ....................................................................................................................T...
M13_kr_od1     ....................................................................................................................T...
M14_kr_jm1     ........................................................................................................................
M14_kr_jm2     ........................................................................................................................
M14_kr_jm3     ........................................................................................................................
M15_kr_dg1     ........................................................................................................................
M16_kr_dr1     ....................................................................................................................T...
M17_kr_sw1     ........................................................................................................................
M17_kr_sw2     ........................................................................................................................
M18_kr_hg1     ....................................................................................................................T...
M19_kr_gy1     ....................................................................................................................T...
M20_kr_nh1     ........................................................................................................................
M20_kr_nh2     ........................................................................................................................
M21_kr_gu1     ....................................................................................................................T...
M22_kr_mp1     ....................................................................................................................T...
M23_kr_bc1     ....................................................................................................................T...
M24_kr_os1     ....................................................................................................................T...
M25_kr_os2     ....................................................................................................................T...
M25_kr_os3     ........................................................................................................................
M25_kr_os4     ....................................................................................................................T...
M25_kr_os5     ....................................................................................................................T...
M26_kr_sn1     ....................................................................................................................T...
M27_kr_gn1     ....................................................................................................................T...
M27_kr_gn2     ....................................................................................................................T...
M28_kr_bs1     ........................................................................................................................
M28_kr_bs2     ....................................................................................................................T...
M28_kr_bs3     ........................................................................................................................
M29_kr_jn1     ....................................................................................................................T...
M30_kr_bl1     ....................................................................................................................T...
M30_kr_bl2     ........................................................................................................................
M31_kr_jl1     ........................................................................................................................
M31_kr_jl2     ....................................................................................................................T...
M32_kr_mt1     ....................................................................................................................T...
M33_kr_md1     ....................................................................................................................T...
M33_kr_md2     ....................................................................................................................T...
```

Appendix 2. (Continued).

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                                                                                                                                  2040
A1_kr_gr1      GTCTATTCAACAAATAAATAGCAATTCTATCTACCAATCCGTATGGTCTTGGACCATCAATAATGATTTTTCTTTAGAGTTCGGTTACTTGGTTGATCCGCTTACTTCTATTATGTCAAT
M34_kr_dn1     ....................................................................................................................T...
M34_kr_dn2     ....................................................................................................................T...
M35_kr_sm1     ...........................................G............................................................................T...
M35_kr_sm2     ...........................................G............................................................................T...
P1_rs_ms1      ....................................................................................................................T...
P1_rs_ms2      ....................................................................................................................T...
P1_rs_ms3      ....................................................................................................................T...
P1_rs_ms4      ....................................................................................................................T...
P2_rs_nk1      ....................................................................................................................T...
P2_rs_nk2      ....................................................................................................................T...
P3_rs_pr1      ....................................................................................................................T...
P4_rs_pr2      ....................................................................................................................T...
P4_rs_pr3      ........................................................................................................................
P5_rs_rc1      ........................................................................................................................
P5_rs_rc2      ....................................................................................................................T...
P5_rs_rc3      ....................................................................................................................T...
P6_rs_rc4      ........................................................................................................................
P6_rs_rc5      ........................................................................................................................
P6_rs_rc6      ........................................................................................................................
P6_rs_rc7      ........................................................................................................................
P6_rs_rc8      ....................................................................................................................T...
P7_rs_us1      ....................................................................................................................T...
P7_rs_us2      ....................................................................................................................T...
P8_rs_pr4      ....................................................................................................................T...
P9_rs_pr5      ........................................................................................................................
P10_cn_jl1     ....................................................................................................................T...
P10_cn_jl2     ....................................................................................................................T...
P11_cn_jl3     ....................................................................................................................T...
P11_cn_jl4     ....................................................................................................................T...
P12_cn_sn1     ....................................................................................................................T...
P12_cn_sn2     ....................................................................................................................T...
P13_cn_mc1     ....................................................................................................................T...
P13_cn_mc2     ....................................................................................................................T...
P14_kr_hw1     ....................................................................................................................T...
P14_kr_hw2     ....................................................................................................................T...
P15_kr_dm1     ........................................................................................................................
P15_kr_dm2     ........................................................................................................................
P15_kr_dm3     ........................................................................................................................
P16_kr_sk1     ....................................................................................................................T...
P16_kr_sk2     ....................................................................................................................T...
P16_kr_sk3     ....................................................................................................................T...
P16_kr_sk4     ....................................................................................................................T...
P16_kr_sk5     ....................................................................................................................T...
P16_kr_sk6     ....................................................................................................................T...
P16_kr_sk7     ....................................................................................................................T...
P16_kr_sk8     ....................................................................................................................T...
P17_kr_sh1     ........................................................................................................................
P18_kr_gb1     ....................................................................................................................T...
P19_kr_gw1     ....................................................................................................................T...
P19_kr_gw2     ....................................................................................................................T...
P19_kr_gw3     ....................................................................................................................T...
P20_kr_ck1     ....................................................................................................................T...
P20_kr_ck2     ....................................................................................................................T...
P21_kr_hc1     ....................................................................................................................T...
P22_kr_hb1     ....................................................................................................................T...
P23_kr_hb2     ....................................................................................................................T...
P24_kr_mh1     ....................................................................................................................T...
P24_kr_mh2     ....................................................................................................................T...
p25_kr_tb1     ....................................................................................................................T...
p25_kr_tb2     ....................................................................................................................T...
P26_kr_tb3     ....................................................................................................................T...
P27_kr_so1     ....................................................................................................................T...
P27_kr_so2     ....................................................................................................................T...
P27_kr_so3     ....................................................................................................................T...
P27_kr_so4     ....................................................................................................................T...
P27_kr_so5     ....................................................................................................................T...
P27_kr_so6     ....................................................................................................................T...
P28_kr_il1     ....................................................................................................................T...
P29_kr_mj1     ....................................................................................................................T...
P29_kr_mj2     ....................................................................................................................T...
P30_kr_dk1     ....................................................................................................................T...
P31_kr_jr1     ....................................................................................................................T...
P32_kr_jr2     ....................................................................................................................T...
O1_jp_rb1      ....................................................................................................................T...
O2_jp_hk1      ....................................................................................................................T...
O2_jp_hk2      ....................................................................................................................T...
O2_jp_hk3      ....................................................................................................................T...
O2_jp_hk4      ....................................................................................................................T...
J1_jp_hn1      ....................................................................................................................T...
J1_jp_hn2      ....................................................................................................................T...
J2_jp_ky1      ........................................................................................................................
J3_jp_jp1      ....................................................................................................................T...
B1_cn_bj1      ........................................................................................................................
B2_uk_1        ........................................................................................................................
AMP_cn_1       ........................................................................................................................
SUF_kr_hl1     ................................................................................................................C.......
SUF_kr_hl2     ................................................................................................................C.......
```

Appendix 2. (Continued).

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                                                                                                                                        2160
A1_kr_gr1       GTTAATCACTACTGTTGGTATTCTAGTTCTTATTTATAGTGACAGTTATATGTCTCATGATCAAGGATATTTAAGATTCTTTGCTTATCTGAGTTTTTTCAATACTTCTATGCTTGGCTT
A1_kr_gr2       ........................................................................................................................
A2_kr_hl1       ........................................................................................................................
A2_kr_hl2       ........................................................................................................................
A2_kr_hl3       ........................................................................................................................
A2_kr_hl4       ........................................................................................................................
A3_kr_hl5       ........................................................................................................................
A3_kr_hl6       ........................................................................................................................
A3_kr_hl7       ........................................................................................................................
A3_kr_hl8       ........................................................................................................................
A4_kr_hl9       ........................................................................................................................
A5_kr_hl10      ........................................................................................................................
A5_kr_hl11      ........................................................................................................................
A5_kr_hl12      ........................................................................................................................
A5_kr_hl13      ........................................................................................................................
A5_kr_hl14      ........................................................................................................................
A7_mn_1         ........................................................................................................................
A8_mn_2         ........................................................................................................................
M1_rs_kb1       ........................................................................................................................
M2_rs_kh1       ........................................................................................................................
M2_rs_kh2       ........................................................................................................................
M2_rs_kh3       ........................................................................................................................
M3_rs_kh4       ........................................................................................................................
M3_rs_kh5       ........................................................................................................................
M3_rs_kh6       ........................................................................................................................
M3_rs_kh7       ........................................................................................................................
M3_rs_kh8       ........................................................................................................................
M3_rs_kh9       ........................................................................................................................
M3_rs_kh10      ........................................................................................................................
M3_rs_kh11      ........................................................................................................................
M3_rs_kh12      ........................................................................................................................
M3_rs_kh13      ........................................................................................................................
M3_rs_kh14      ........................................................................................................................
M3_rs_kh15      ........................................................................................................................
M3_rs_kh16      ........................................................................................................................
M3_rs_kh17      ........................................................................................................................
M3_rs_kh18      ........................................................................................................................
M3_rs_kh19      ........................................................................................................................
M3_rs_kh20      ........................................................................................................................
M3_rs_kh21      ........................................................................................................................
M3_rs_kh22      ........................................................................................................................
M3_rs_kh23      ........................................................................................................................
M3_rs_kh24      ........................................................................................................................
M3_rs_kh25      ........................................................................................................................
M3_rs_kh26      ........................................................................................................................
M3_rs_kh27      ........................................................................................................................
M3_rs_kh28      ........................................................................................................................
M3_rs_kh29      ........................................................................................................................
M3_rs_kh30      ........................................................................................................................
M3_rs_kh31      ........................................................................................................................
M4_rs_kh32      ........................................................................................................................
M5_rs_ot1       ........................................................................................................................
M6_rs_ri1       ........................................................................................................................
M6_rs_ri2       ........................................................................................................................
M7_cn_hj1       ........................................................................................................................
M8_cn_hj2       ........................................................................................................................
M8_cn_hj3       ........................................................................................................................
M8_cn_hj4       ........................................................................................................................
M9_cn_hj5       ........................................................................................................................
M10_cn_nm1      ........................................................................................................................
M11_cn_ul1      ........................................................................................................................
M12_cn_sb1      ........................................................................................................................
M12_cn_sb2      ........................................................................................................................
M13_kr_od1      ........................................................................................................................
M14_kr_jm1      ........................................................................................................................
M14_kr_jm2      ........................................................................................................................
M14_kr_jm3      ........................................................................................................................
M15_kr_dg1      ........................................................................................................................
M16_kr_dr1      ........................................................................................................................
M17_kr_sw1      ........................................................................................................................
M17_kr_sw2      ........................................................................................................................
M18_kr_hg1      ........................................................................................................................
M19_kr_gy1      ........................................................................................................................
M20_kr_nh1      ........................................................................................................................
M20_kr_nh2      ........................................................................................................................
M21_kr_gu1      ........................................................................................................................
M22_kr_mp1      ........................................................................................................................
M23_kr_bc1      ........................................................................................................................
M24_kr_os1      ........................................................................................................................
M25_kr_os2      ........................................................................................................................
M25_kr_os3      ........................................................................................................................
M25_kr_os4      ........................................................................................................................
M25_kr_os5      ........................................................................................................................
M26_kr_sn1      ........................................................................................................................
M27_kr_gn1      ........................................................................................................................
M27_kr_gn2      ........................................................................................................................
M28_kr_bs1      ........................................................................................................................
M28_kr_bs2      ........................................................................................................................
M28_kr_bs3      ........................................................................................................................
M29_kr_jn1      ........................................................................................................................
M30_kr_bl1      ........................................................................................................................
M30_kr_bl2      ........................................................................................................................
M31_kr_jl1      ........................................................................................................................
M31_kr_jl2      ........................................................................................................................
M32_kr_mt1      ........................................................................................................................
M33_kr_md1      ........................................................................................................................
M33_kr_md2      ........................................................................................................................
```

Appendix 2. (Continued).

```
                                                                                                                                   2160
A1_kr_gr1      GTTAATCACTACTGTTGGTATTCTAGTTCTTATTTATAGTGACAGTTATATGTCTCATGATCAAGGATATTTAAGATTCTTTGCTTATCTGAGTTTTTTCAATACTTCTATGCTTGGCTT
M34_kr_dn1     ........................................................................................................................
M34_kr_dn2     ........................................................................................................................
M35_kr_sm1     ........................................................................................................................
M35_kr_sm2     ........................................................................................................................
P1_rs_ms1      ........................................................................................................................
P1_rs_ms2      ........................................................................................................................
P1_rs_ms3      ........................................................................................................................
P1_rs_ms4      ........................................................................................................................
P2_rs_nk1      ........................................................................................................................
P2_rs_nk2      ........................................................................................................................
P3_rs_pr1      ........................................................................................................................
P4_rs_pr2      ........................................................................................................................
P4_rs_pr3      ........................................................................................................................
P5_rs_rc1      ........................................................................................................................
P5_rs_rc2      ........................................................................................................................
P5_rs_rc3      ........................................................................................................................
P6_rs_rc4      ........................................................................................................................
P6_rs_rc5      ........................................................................................................................
P6_rs_rc6      ........................................................................................................................
P6_rs_rc7      ........................................................................................................................
P6_rs_rc8      ........................................................................................................................
P7_rs_us1      ........................................................................................................................
P7_rs_us2      ........................................................................................................................
P8_rs_pr4      ........................................................................................................................
P9_rs_pr5      ........................................................................................................................
P10_cn_jl1     ........................................................................................................................
P10_cn_jl2     ........................................................................................................................
P11_cn_jl3     ........................................................................................................................
P11_cn_jl4     ........................................................................................................................
P12_cn_sn1     ........................................................................................................................
P12_cn_sn2     ........................................................................................................................
P13_cn_mc1     ........................................................................................................................
P13_cn_mc2     ........................................................................................................................
P14_kr_hw1     ........................................................................................................................
P14_kr_hw2     ........................................................................................................................
P15_kr_dm1     ........................................................................................................................
P15_kr_dm2     ........................................................................................................................
P15_kr_dm3     ........................................................................................................................
P16_kr_sk1     ........................................................................................................................
P16_kr_sk2     ........................................................................................................................
P16_kr_sk3     ........................................................................................................................
P16_kr_sk4     ........................................................................................................................
P16_kr_sk5     ........................................................................................................................
P16_kr_sk6     ........................................................................................................................
P16_kr_sk7     ........................................................................................................................
P16_kr_sk8     ........................................................................................................................
P17_kr_sh1     ........................................................................................................................
P18_kr_gb1     ........................................................................................................................
P19_kr_gw1     ........................................................................................................................
P19_kr_gw2     ........................................................................................................................
P19_kr_gw3     ........................................................................................................................
P20_kr_ck1     ........................................................................................................................
P20_kr_ck2     ........................................................................................................................
P21_kr_hc1     ........................................................................................................................
P22_kr_hb1     ........................................................................................................................
P23_kr_hb2     ........................................................................................................................
P24_kr_mh1     ........................................................................................................................
P24_kr_mh2     ........................................................................................................................
p25_kr_tb1     ........................................................................................................................
p25_kr_tb2     ........................................................................................................................
P26_kr_tb3     ........................................................................................................................
P27_kr_so1     ........................................................................................................................
P27_kr_so2     ........................................................................................................................
P27_kr_so3     ........................................................................................................................
P27_kr_so4     ........................................................................................................................
P27_kr_so5     ........................................................................................................................
P27_kr_so6     ........................................................................................................................
P28_kr_il1     ........................................................................................................................
P29_kr_mj1     ........................................................................................................................
P29_kr_mj2     ........................................................................................................................
P30_kr_dk1     ........................................................................................................................
P31_kr_jr1     ........................................................................................................................
P32_kr_jr2     ........................................................................................................................
O1_jp_rb1      ........................................................................................................................
O2_jp_hk1      ........................................................................................................................
O2_jp_hk2      ........................................................................................................................
O2_jp_hk3      ........................................................................................................................
O2_jp_hk4      ........................................................................................................................
J1_jp_hn1      ........................................................................................................................
J1_jp_hn2      ........................................................................................................................
J2_jp_ky1      ........................................................................................................................
J3_jp_jp1      ........................................................................................................................
B1_cn_bj1      ........................................................................................................................
B2_uk_1        ........................................................................................................................
AMP_cn_1       ............................A...........................................................................................
SUF_kr_hl1     .........................................................................................................C..............
SUF_kr_hl2     .........................................................................................................C..............
```

Appendix 2. (Continued).

```
                                                                                                                                   2280
A1_kr_gr1      AGTTACAAGTTCGAATTTACTACAAATTTATATTTTTTGGGAATTAGTTGGGATGTGCTCGTATCTATTAATAGGTTTTTGGTTTACACGACCTATTGCAGCAAATGCTTGTCAAAAAGC
A1_kr_gr2      ........................................................................................................................
A2_kr_hl1      ........................................................................................................................
A2_kr_hl2      ........................................................................................................................
A2_kr_hl3      ........................................................................................................................
A2_kr_hl4      ........................................................................................................................
A3_kr_hl5      ........................................................................................................................
A3_kr_hl6      ........................................................................................................................
A3_kr_hl7      ........................................................................................................................
A3_kr_hl8      ........................................................................................................................
A4_kr_hl9      ........................................................................................................................
A5_kr_hl10     ........................................................................................................................
A5_kr_hl11     ........................................................................................................................
A5_kr_hl12     ........................................................................................................................
A5_kr_hl13     ........................................................................................................................
A5_kr_hl14     ........................................................................................................................
A7_mn_1        ........................................................................................................................
A8_mn_2        ........................................................................................................................
M1_rs_kb1      ........................................................................................................................
M2_rs_kh1      ........................................................................................................................
M2_rs_kh2      ........................................................................................................................
M2_rs_kh3      ........................................................................................................................
M3_rs_kh4      ........................................................................................................................
M3_rs_kh5      ........................................................................................................................
M3_rs_kh6      ........................................................................................................................
M3_rs_kh7      ........................................................................................................................
M3_rs_kh8      ........................................................................................................................
M3_rs_kh9      ........................................................................................................................
M3_rs_kh10     ........................................................................................................................
M3_rs_kh11     ........................................................................................................................
M3_rs_kh12     ........................................................................................................................
M3_rs_kh13     ........................................................................................................................
M3_rs_kh14     ........................................................................................................................
M3_rs_kh15     ........................................................................................................................
M3_rs_kh16     ........................................................................................................................
M3_rs_kh17     ........................................................................................................................
M3_rs_kh18     ........................................................................................................................
M3_rs_kh19     ........................................................................................................................
M3_rs_kh20     ........................................................................................................................
M3_rs_kh21     ........................................................................................................................
M3_rs_kh22     ........................................................................................................................
M3_rs_kh23     ........................................................................................................................
M3_rs_kh24     ........................................................................................................................
M3_rs_kh25     ........................................................................................................................
M3_rs_kh26     ........................................................................................................................
M3_rs_kh27     ........................................................................................................................
M3_rs_kh28     ........................................................................................................................
M3_rs_kh29     ........................................................................................................................
M3_rs_kh30     ........................................................................................................................
M3_rs_kh31     ........................................................................................................................
M4_rs_kh32     ........................................................................................................................
M5_rs_ot1      ........................................................................................................................
M6_rs_ri1      ........................................................................................................................
M6_rs_ri2      ........................................................................................................................
M8_cn_hj2      ........................................................................................................................
M8_cn_hj3      ........................................................................................................................
M8_cn_hj4      ........................................................................................................................
M7_cn_hj1      ........................................................................................................................
M9_cn_hj5      ........................................................................................................................
M10_cn_nm1     ........................................................................................................................
M11_cn_ul1     ........................................................................................................................
M12_cn_sb1     ........................................................................................................................
M12_cn_sb2     ........................................................................................................................
M13_kr_od1     ........................................................................................................................
M14_kr_jm1     ........................................................................................................................
M14_kr_jm2     ........................................................................................................................
M14_kr_jm3     ........................................................................................................................
M15_kr_dg1     ........................................................................................................................
M16_kr_dr1     ........................................................................................................................
M17_kr_sw1     ........................................................................................................................
M17_kr_sw2     ........................................................................................................................
M18_kr_hg1     ........................................................................................................................
M19_kr_gy1     ........................................................................................................................
M20_kr_nh1     ........................................................................................................................
M20_kr_nh2     ........................................................................................................................
M21_kr_gu1     ........................................................................................................................
M22_kr_mp1     ........................................................................................................................
M23_kr_bc1     ........................................................................................................................
M24_kr_os1     ........................................................................................................................
M25_kr_os2     ........................................................................................................................
M25_kr_os3     ........................................................................................................................
M25_kr_os4     ........................................................................................................................
M25_kr_os5     ........................................................................................................................
M26_kr_sn1     ........................................................................................................................
M27_kr_gn1     ........................................................................................................................
M27_kr_gn2     ........................................................................................................................
M28_kr_bs1     ........................................................................................................................
M28_kr_bs2     ........................................................................................................................
M28_kr_bs3     ........................................................................................................................
M29_kr_jn1     ........................................................................................................................
M30_kr_bl1     ........................................................................................................................
M30_kr_bl2     ........................................................................................................................
M31_kr_jl1     ........................................................................................................................
M31_kr_jl2     ........................................................................................................................
M32_kr_mt1     ........................................................................................................................
M33_kr_md1     ........................................................................................................................
M33_kr_md2     ........................................................................................................................
```

Appendix 2. (Continued).

```
                                                                                                                                  2280
A1_kr_gr1      AGTTACAAGTTCGAATTTACTACAAATTTATATTTTTTGGGAATTAGTTGGGATGTGCTCGTATCTATTAATAGGTTTTTGGTTTACACGACCTATTGCAGCAAATGCTTGTCAAAAAGC
M34_kr_dn1     ........................................................................................................................
M34_kr_dn2     ........................................................................................................................
M35_kr_sm1     ........................................................................................................................
M35_kr_sm2     ........................................................................................................................
P1_rs_ms1      ........................................................................................................................
P1_rs_ms2      ........................................................................................................................
P1_rs_ms3      ........................................................................................................................
P1_rs_ms4      ........................................................................................................................
P2_rs_nk1      ........................................................................................................................
P2_rs_nk2      ........................................................................................................................
P3_rs_pr1      ........................................................................................................................
P4_rs_pr2      ........................................................................................................................
P4_rs_pr3      ........................................................................................................................
P5_rs_rc1      ........................................................................................................................
P5_rs_rc2      ........................................................................................................................
P5_rs_rc3      ........................................................................................................................
P6_rs_rc4      ........................................................................................................................
P6_rs_rc5      ........................................................................................................................
P6_rs_rc6      ........................................................................................................................
P6_rs_rc7      ........................................................................................................................
P6_rs_rc8      ........................................................................................................................
P7_rs_us1      ........................................................................................................................
P7_rs_us2      ........................................................................................................................
P8_rs_pr4      ........................................................................................................................
P9_rs_pr5      ........................................................................................................................
P10_cn_jl1     ........................................................................................................................
P10_cn_jl2     ........................................................................................................................
P11_cn_jl3     ........................................................................................................................
P11_cn_jl4     ........................................................................................................................
P12_cn_sn1     ........................................................................................................................
P12_cn_sn2     ........................................................................................................................
P13_cn_mc1     ........................................................................................................................
P13_cn_mc2     ........................................................................................................................
P14_kr_hw1     ........................................................................................................................
P14_kr_hw2     ........................................................................................................................
P15_kr_dm1     ........................................................................................................................
P15_kr_dm2     ........................................................................................................................
P15_kr_dm3     ........................................................................................................................
P16_kr_sk1     ........................................................................................................................
P16_kr_sk2     ........................................................................................................................
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P16_kr_sk4     ........................................................................................................................
P16_kr_sk5     ........................................................................................................................
P16_kr_sk6     ........................................................................................................................
P16_kr_sk7     ........................................................................................................................
P16_kr_sk8     ........................................................................................................................
P17_kr_sh1     ........................................................................................................................
P18_kr_gb1     ........................................................................................................................
P19_kr_gw1     ........................................................................................................................
P19_kr_gw2     ........................................................................................................................
P19_kr_gw3     ........................................................................................................................
P20_kr_ck1     ........................................................................................................................
P20_kr_ck2     ........................................................................................................................
P21_kr_hc1     ........................................................................................................................
P22_kr_hb1     ........................................................................................................................
P23_kr_hb2     ........................................................................................................................
P24_kr_mh1     ........................................................................................................................
P24_kr_mh2     ........................................................................................................................
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P27_kr_so2     ........................................................................................................................
P27_kr_so3     ........................................................................................................................
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P27_kr_so5     ........................................................................................................................
P27_kr_so6     ........................................................................................................................
P28_kr_il1     ........................................................................................................................
P29_kr_mj1     ........................................................................................................................
P29_kr_mj2     ........................................................................................................................
P30_kr_dk1     ........................................................................................................................
P31_kr_jr1     ........................................................................................................................
P32_kr_jr2     ........................................................................................................................
O1_jp_rb1      ........................................................................................................................
O2_jp_hk1      ........................................................................................................................
O2_jp_hk2      ........................................................................................................................
O2_jp_hk3      ........................................................................................................................
O2_jp_hk4      ........................................................................................................................
J1_jp_hn1      ........................................................................................................................
J1_jp_hn2      ........................................................................................................................
J2_jp_ky1      ........................................................................................................................
J3_jp_jp1      ........................................................................................................................
B1_cn_bj1      ........................................................................................................................
B2_uk_1        ........................................................................................................................
AMP_cn_1       ...................................................A....................................................................
SUF_kr_hl1     ............A......................................A....................................................................
SUF_kr_hl2     ............A......................................A....................................................................
```

Appendix 2. (Continued).

```
                                                                                                                                    2400
A1_kr_gr1       ATTTGTGACGAATCGTGTAGGGGATTTTGGTTTATTATTAGGAATTTTAGGTCTTTATTGGCTAACGGGCAGTTTCGAATTTCGAGATTTGTTCGAAATATTCAATACCTCCATTTCGAA
A1_kr_gr2       ........................................................................................................................
A2_kr_hl1       ........................................................................................................................
A2_kr_hl2       ........................................................................................................................
A2_kr_hl3       ........................................................................................................................
A2_kr_hl4       ........................................................................................................................
A3_kr_hl5       ........................................................................................................................
A3_kr_hl6       ........................................................................................................................
A3_kr_hl7       ........................................................................................................................
A3_kr_hl8       ........................................................................................................................
A4_kr_hl9       ........................................................................................................................
A5_kr_hl10      ........................................................................................................................
A5_kr_hl11      ........................................................................................................................
A5_kr_hl12      ........................................................................................................................
A5_kr_hl13      ........................................................................................................................
A5_kr_hl14      ........................................................................................................................
A7_mn_1         .....................................................................................................................T..
A8_mn_2         .....................................................................................................................T..
M1_rs_kb1       .................................................................................A......................................
M2_rs_kh1       ........................................................................................................................
M2_rs_kh2       ........................................................................................................................
M2_rs_kh3       ........................................................................................................................
M3_rs_kh4       ........................................................................................................................
M3_rs_kh5       ........................................................................................................................
M3_rs_kh6       ........................................................................................................................
M3_rs_kh7       ........................................................................................................................
M3_rs_kh8       ........................................................................................................................
M3_rs_kh9       ........................................................................................................................
M3_rs_kh10      ........................................................................................................................
M3_rs_kh11      ........................................................................................................................
M3_rs_kh12      ........................................................................................................................
M3_rs_kh13      ........................................................................................................................
M3_rs_kh14      ........................................................................................................................
M3_rs_kh15      ........................................................................................................................
M3_rs_kh16      ........................................................................................................................
M3_rs_kh17      ........................................................................................................................
M3_rs_kh18      ........................................................................................................................
M3_rs_kh19      ........................................................................................................................
M3_rs_kh20      ........................................................................................................................
M3_rs_kh21      ........................................................................................................................
M3_rs_kh22      ........................................................................................................................
M3_rs_kh23      ........................................................................................................................
M3_rs_kh24      ........................................................................................................................
M3_rs_kh25      ........................................................................................................................
M3_rs_kh26      ........................................................................................................................
M3_rs_kh27      ........................................................................................................................
M3_rs_kh28      ........................................................................................................................
M3_rs_kh29      ........................................................................................................................
M3_rs_kh30      ........................................................................................................................
M3_rs_kh31      ........................................................................................................................
M4_rs_kh32      ........................................................................................................................
M5_rs_ot1       ........................................................................................................................
M6_rs_ri1       ........................................................................................................................
M6_rs_ri2       ........................................................................................................................
M7_cn_hj1       ........................................................................................................................
M8_cn_hj2       ........................................................................................................................
M8_cn_hj3       ........................................................................................................................
M8_cn_hj4       ........................................................................................................................
M9_cn_hj5       ........................................................................................................................
M10_cn_nm1      ........................................................................................................................
M11_cn_ul1      ........................................................................................................................
M12_cn_sb1      ........................................................................................................................
M12_cn_sb2      ........................................................................................................................
M13_kr_od1      ........................................................................................................................
M14_kr_jm1      ........................................................................................................................
M14_kr_jm2      ........................................................................................................................
M14_kr_jm3      ........................................................................................................................
M15_kr_dg1      ........................................................................................................................
M16_kr_dr1      ........................................................................................................................
M17_kr_sw1      ........................................................................................................................
M17_kr_sw2      ........................................................................................................................
M18_kr_hg1      ........................................................................................................................
M19_kr_gy1      ........................................................................................................................
M20_kr_nh1      ........................................................................................................................
M20_kr_nh2      ........................................................................................................................
M21_kr_gu1      ........................................................................................................................
M22_kr_mp1      ........................................................................................................................
M23_kr_bc1      ........................................................................................................................
M24_kr_os1      ........................................................................................................................
M25_kr_os2      ........................................................................................................................
M25_kr_os3      ........................................................................................................................
M25_kr_os4      ........................................................................................................................
M25_kr_os5      ........................................................................................................................
M26_kr_sn1      ........................................................................................................................
M27_kr_gn1      ........................................................................................................................
M27_kr_gn2      ........................................................................................................................
M28_kr_bs1      ........................................................................................................................
M28_kr_bs2      ........................................................................................................................
M28_kr_bs3      ........................................................................................................................
M29_kr_jn1      ........................................................................................................................
M30_kr_bl1      ........................................................................................................................
M30_kr_bl2      ........................................................................................................................
M31_kr_jl1      ........................................................................................................................
M31_kr_jl2      ........................................................................................................................
M32_kr_mt1      ........................................................................................................................
M33_kr_md1      ........................................................................................................................
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Appendix 2. (Continued).

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                                                                                                                                   2400
A1_kr_gr1      ATTTGTGACGAATCGTGTAGGGGATTTTGGTTTATTATTAGGAATTTTAGGTCTTTATTGGCTAACGGGCAGTTTCGAATTTCGAGATTTGTTCGAAATATTCAATACCTCCATTTCGAA
M33_kr_md2     ........................................................................................................................
M34_kr_dn1     ........................................................................................................................
M34_kr_dn2     ........................................................................................................................
M35_kr_sm1     ..................................................................................A.....................................
M35_kr_sm2     ..................................................................................A.....................................
P1_rs_ms1      .....................................................................................................................T..
P1_rs_ms2      .....................................................................................................................T..
P1_rs_ms3      ......................................................................................................A.................
P1_rs_ms4      .....................................................................................................................T..
P2_rs_nk1      .....................................................................................................................T..
P2_rs_nk2      .....................................................................................................................T..
P3_rs_pr1      ........................................................................................................................
P4_rs_pr2      ........................................................................................................................
P4_rs_pr3      ........................................................................................................................
P5_rs_rc1      ........................................................................................................................
P5_rs_rc2      ........................................................................................................................
P5_rs_rc3      ........................................................................................................................
P6_rs_rc4      ........................................................................................................................
P6_rs_rc5      ........................................................................................................................
P6_rs_rc6      ........................................................................................................................
P6_rs_rc7      ........................................................................................................................
P6_rs_rc8      ........................................................................................................................
P7_rs_us1      ........................................................................................................................
P7_rs_us2      ........................................................................................................................
P8_rs_pr4      ........................................................................................................................
P9_rs_pr5      ........................................................................................................................
P10_cn_jl1     ........................................................................................................................
P10_cn_jl2     ........................................................................................................................
P11_cn_jl3     ........................................................................................................................
P11_cn_jl4     ........................................................................................................................
P12_cn_sn1     ........................................................................................................................
P12_cn_sn2     ........................................................................................................................
P13_cn_mc1     ........................................................................................................................
P13_cn_mc2     ........................................................................................................................
P14_kr_hw1     ........................................................................................................................
P14_kr_hw2     ........................................................................................................................
P15_kr_dm1     ........................................................................................................................
P15_kr_dm2     ........................................................................................................................
P15_kr_dm3     ........................................................................................................................
P16_kr_sk1     ........................................................................................................................
P16_kr_sk2     ........................................................................................................................
P16_kr_sk3     ........................................................................................................................
P16_kr_sk4     ........................................................................................................................
P16_kr_sk5     ........................................................................................................................
P16_kr_sk6     ........................................................................................................................
P16_kr_sk7     ........................................................................................................................
P16_kr_sk8     ........................................................................................................................
P17_kr_sh1     ........................................................................................................................
P18_kr_gb1     ........................................................................................................................
P19_kr_gw1     ........................................................................................................................
P19_kr_gw2     ........................................................................................................................
P19_kr_gw3     ........................................................................................................................
P20_kr_ck1     ........................................................................................................................
P20_kr_ck2     ........................................................................................................................
P21_kr_hc1     ........................................................................................................................
P22_kr_hb1     ........................................................................................................................
P23_kr_hb2     ........................................................................................................................
P24_kr_mh1     ........................................................................................................................
P24_kr_mh2     ........................................................................................................................
p25_kr_tb1     ........................................................................................................................
p25_kr_tb2     ........................................................................................................................
P26_kr_tb3     ........................................................................................................................
P27_kr_so1     ........................................................................................................................
P27_kr_so2     ........................................................................................................................
P27_kr_so3     ........................................................................................................................
P27_kr_so4     ........................................................................................................................
P27_kr_so5     ........................................................................................................................
P27_kr_so6     ........................................................................................................................
P28_kr_il1     ........................................................................................................................
P29_kr_mj1     ........................................................................................................................
P29_kr_mj2     ........................................................................................................................
P30_kr_dk1     ........................................................................................................................
P31_kr_jr1     ........................................................................................................................
P32_kr_jr2     ........................................................................................................................
O1_jp_rb1      .....................................................................................................................T..
O2_jp_hk1      ........................................................................................................................
O2_jp_hk2      .....................................................................................................................T..
O2_jp_hk3      .....................................................................................................................T..
O2_jp_hk4      .....................................................................................................................T..
J1_jp_hn1      .....................................................................................................................T..
J1_jp_hn2      .....................................................................................................................T..
J2_jp_ky1      ........................................................................................................................
J3_jp_jp1      .....................................................................................................................T..
B1_cn_bj1      .........................................................................................................C..............
B2_uk_1        ........................................................................................................................
AMP_cn_1       G.......................................................................................................................
SUF_kr_hl1     G.........................................C..............................................................................
SUF_kr_hl2     G.........................................C..............................................................................
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Appendix 2. (Continued).

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                                                                                                                                  2520
A1_kr_gr1      TAATGAAATAAATTTGTTAATTGGAACTGTATGCACTTTCTTATTATTTGCTGGTGCAGTTGCCAAATCCGCGCAATTCCCCCTTCATTTATGGTTACCTGATGCTATGGAGGGGCCTAC
A1_kr_gr2      .........C..............................................................................................................
A2_kr_hl1      ........................................................................................................................
A2_kr_hl2      ........................................................................................................................
A2_kr_hl3      .........C..............................................................................................................
A2_kr_hl4      ........................................................................................................................
A3_kr_hl5      .........C..............................................................................................................
A3_kr_hl6      .........C..............................................................................................................
A3_kr_hl7      ........................................................................................................................
A3_kr_hl8      ........................................................................................................................
A4_kr_hl9      ........................................................................................................................
A5_kr_hl10     .........C..............................................................................................................
A5_kr_hl11     .........C..............................................................................................................
A5_kr_hl12     .........C..............................................................................................................
A5_kr_hl13     .........C..............................................................................................................
A5_kr_hl14     .........C................................T.............................................................................
A7_mn_1        .........C..............................................................................................................
A8_mn_2        .........C..............................................................................................................
M1_rs_kb1      .........C..............................................................................................................
M2_rs_kh1      .........C..............................................................................................................
M2_rs_kh2      .........C..............................................................................................................
M2_rs_kh3      .........C..............................................................................................................
M3_rs_kh4      .........C..............................................................................................................
M3_rs_kh5      .........C..............................................................................................................
M3_rs_kh6      ..........................................................................................C.............................
M3_rs_kh7      ..........................................................................................C.............................
M3_rs_kh8      .........C..............................................................................................................
M3_rs_kh9      ..........................................................................................C.............................
M3_rs_kh10     ..........................................................................................C.............................
M3_rs_kh11     ..........................................................................................C.............................
M3_rs_kh12     ..........................................................................................C.............................
M3_rs_kh13     ..........................................................................................C.............................
M3_rs_kh14     ..........................................................................................C.............................
M3_rs_kh15     .........C..............................................................................................................
M3_rs_kh16     .........C..............................................................................................................
M3_rs_kh17     .........C..............................................................................................................
M3_rs_kh18     ..........................................................................................C.............................
M3_rs_kh19     .........C..............................................................................................................
M3_rs_kh20     ..........................................................................................C.............................
M3_rs_kh21     .........C..............................................................................................................
M3_rs_kh22     .........C..............................................................................................................
M3_rs_kh23     ..........................................................................................C.............................
M3_rs_kh24     .........C..............................................................................................................
M3_rs_kh25     .........C..............................................................................................................
M3_rs_kh26     ..........................................................................................C.............................
M3_rs_kh27     .........C..............................................................................................................
M3_rs_kh28     .........C..............................................................................................................
M3_rs_kh29     .........C..............................................................................................................
M3_rs_kh30     ..........................................................................................C.............................
M3_rs_kh31     .........C..............................................................................................................
M4_rs_kh32     .........C..............................................................................................................
M5_rs_ot1      ........................................................................................................................
M6_rs_ri1      ........................................................................................................................
M6_rs_ri2      .........C..............................................................................................................
M7_cn_hj1      ........................................................................................................................
M8_cn_hj2      .........C..............................................................................................................
M8_cn_hj3      .........C..............................................................................................................
M8_cn_hj4      .........C..............................................................................................................
M9_cn_hj5      .........C..............................................................................................................
M10_cn_nm1     .........C..............................................................................................................
M11_cn_ul1     .........C..............................................................................................................
M12_cn_sb1     .........C..............................................................................................................
M12_cn_sb2     .........C..............................................................................................................
M13_kr_od1     .........C..............................................................................................................
M14_kr_jm1     ..........................................................................................C.............................
M14_kr_jm2     ..........................................................................................C.............................
M14_kr_jm3     ..........................................................................................C.............................
M15_kr_dg1     ........................................................................................................................
M16_kr_dr1     .........C..............................................................................................................
M17_kr_sw1     ........................................................................................................................
M17_kr_sw2     ........................................................................................................................
M18_kr_hg1     .........C..............................................................................................................
M19_kr_gy1     .........C..............................................................................................................
M20_kr_nh1     ..........................................................................................C.............................
M20_kr_nh2     ..........................................................................................C.............................
M21_kr_gu1     .........C..............................................................................................................
M22_kr_mp1     .........C..............................................................................................................
M23_kr_bc1     .........C..............................................................................................................
M24_kr_os1     .........C..............................................................................................................
M25_kr_os2     .........C..............................................................................................................
M25_kr_os3     ........................................................................................................................
M25_kr_os4     .........C..............................................................................................................
M25_kr_os5     .........C..............................................................................................................
M26_kr_sn1     .........C..............................................................................................................
M27_kr_gn1     .........C................................T.............................................................................
M27_kr_gn2     .........C................................T.............................................................................
M28_kr_bs1     ........................................................................................................................
M28_kr_bs2     .........C........................G.....................................................................................
M28_kr_bs3     ........................................................................................................................
M29_kr_jn1     .........C..............................................................................................................
M30_kr_bl1     .........C..............................................................................................................
M30_kr_bl2     ........................................................................................................................
M31_kr_jl1     ........................................................................................................................
M31_kr_jl2     .........C..............................................................................................................
M32_kr_mt1     .........C..............................................................................................................
M33_kr_md1     .........C..............................................................................................................
M33_kr_md2     .........C..............................................................................................................
```

Appendix 2. (Continued).

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                                                                                                                                          2520
A1_kr_gr1      TAATGAAATAAATTTGTTAATTGGAACTGTATGCACTTTCTTATTATTTGCTGGTGCAGTTGCCAAATCCGCGCAATTCCCCCTTCATTTATGGTTACCTGATGCTATGGAGGGGCCTAC
M34_kr_dn1     .........C..............................................................................................................
M34_kr_dn2     .........C..............................................................................................................
M35_kr_sm1     .........C..............................................................................................................
M35_kr_sm2     .........C..............................................................................................................
P1_rs_ms1      .........C..............................................................................................................
P1_rs_ms2      .........C..............................................................................................................
P1_rs_ms3      .........C..............................................................................................................
P1_rs_ms4      .........C..............................................................................................................
P2_rs_nk1      .........C..............................................................................................................
P2_rs_nk2      .........C..............................................................................................................
P3_rs_pr1      .........C..............................................................................................................
P4_rs_pr2      .........C..............................................................................................................
P4_rs_pr3      ........................................................................................................................
P5_rs_rc1      ........................................................................................................................
P5_rs_rc2      .........C..............................................................................................................
P5_rs_rc3      .........C..............................................................................................................
P6_rs_rc4      ........................................................................................................................
P6_rs_rc5      ........................................................................................................................
P6_rs_rc6      ........................................................................................................................
P6_rs_rc7      ........................................................................................................................
P6_rs_rc8      .........C..............................................................................................................
P7_rs_us1      .........C..............................................................................................................
P7_rs_us2      .........C..............................................................................................................
P8_rs_pr4      .........C..............................................................................................................
P9_rs_pr5      ........................................................................................................................
P10_cn_jl1     .........C..............................................................................................................
P10_cn_jl2     .........C..............................................................................................................
P11_cn_jl3     .........C..............................................................................................................
P11_cn_jl4     .........C..............................................................................................................
P12_cn_sn1     .........C..............................................................................................................
P12_cn_sn2     .........C..............................................................................................................
P13_cn_mc1     .........C..............................................................................................................
P13_cn_mc2     .........C..............................................................................................................
P14_kr_hw1     .........C..............................................................................................................
P14_kr_hw2     .........C..............................................................................................................
P15_kr_dm1     ........................................................................................................................
P15_kr_dm2     ........................................................................................................................
P15_kr_dm3     ........................................................................................................................
P16_kr_sk1     .........C..............................................................................................................
P16_kr_sk2     .........C..............................................................................................................
P16_kr_sk3     .........C..............................................................................................................
P16_kr_sk4     .........C..............................................................................................................
P16_kr_sk5     .........C..............................................................................................................
P16_kr_sk6     .........C..............................................................................................................
P16_kr_sk7     .........C..............................................................................................................
P16_kr_sk8     .........C..............................................................................................................
P17_kr_sh1     ........................................................................................................................
P18_kr_gb1     .........C..............................................................................................................
P19_kr_gw1     .........C..............................................................................................................
P19_kr_gw2     .........C..............................................................................................................
P19_kr_gw3     .........C..............................................................................................................
P20_kr_ck1     .........C..............................................................................................................
P20_kr_ck2     .........C..............................................................................................................
P21_kr_hc1     .........C..............................................................................................................
P22_kr_hb1     .........C..............................................................................................................
P23_kr_hb2     .........C..............................................................................................................
P24_kr_mh1     .........C..............................................................................................................
P24_kr_mh2     .........C..............................................................................................................
p25_kr_tb1     .........C..............................................................................................................
p25_kr_tb2     .........C..............................................................................................................
P26_kr_tb3     .........C..............................................................................................................
P27_kr_so1     .........C..............................................................................................................
P27_kr_so2     .........C..............................................................................................................
P27_kr_so3     .........C..............................................................................................................
P27_kr_so4     .........C..............................................................................................................
P27_kr_so5     .........C..............................................................................................................
P27_kr_so6     .........C..............................................................................................................
P28_kr_il1     .........C..............................................................................................................
P29_kr_mj1     .........C..............................................................................................................
P29_kr_mj2     .........C..............................................................................................................
P30_kr_dk1     .........C..............................................................................................................
P31_kr_jr1     .........C..............................................................................................................
P32_kr_jr2     .........C..............................................................................................................
O1_jp_rb1      .........C..............................................................................................................
O2_jp_hk1      .........C..............................................................................................................
O2_jp_hk2      .........C..............................................................................................................
O2_jp_hk3      .........C..............................................................................................................
O2_jp_hk4      .........C..............................................................................................................
J1_jp_hn1      .........C..............................................................................................................
J1_jp_hn2      .........C..............................................................................................................
J2_jp_ky1      ..........................................................................................C.............................
J3_jp_jp1      .........C..............................................................................................................
B1_cn_bj1      ..........................................................................................C.............................
B2_uk_1        ........................................................................................................................
AMP_cn_1       ..........C.............................................................................G...............................
SUF_kr_hl1     ..........C.............................................................................G...............................
SUF_kr_hl2     ..........C.............................................................................G...............................
```

Appendix 2. (Continued).

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                                                                                                                                   2640
A1_kr_gr1      TCCTATTTCGGCTCTTATACATGCTGCTACTATGGTAGCAGCGGGTATTTTTCTTGTCGCTAGACTTTTTCCTCTTTTGGTAGTCATCCCCTCCATACTCAATCTAATCGCTTTAATAGG
A1_kr_gr2      ........................................................................................................................
A2_kr_hl1      ........................................................................................................................
A2_kr_hl2      ........................................................................................................................
A2_kr_hl3      ........................................................................................................................
A2_kr_hl4      ..............................................................................T.........................................
A3_kr_hl5      ........................................................................................................................
A3_kr_hl6      ........................................................................................................................
A3_kr_hl7      ..............................................................................T.........................................
A3_kr_hl8      ..............................................................................T.........................................
A4_kr_hl9      ........................................................................................................................
A5_kr_hl10     ........................................................................................................................
A5_kr_hl11     ........................................................................................................................
A5_kr_hl12     ........................................................................................................................
A5_kr_hl13     ........................................................................................................................
A5_kr_hl14     ........................................................................................................................
A7_mn_1        ........................................................................................................................
A8_mn_2        ........................................................................................................................
M1_rs_kb1      ........................................................................................................................
M2_rs_kh1      ........................................................................................................................
M2_rs_kh2      ........................................................................................................................
M2_rs_kh3      ........................................................................................................................
M3_rs_kh4      ........................................................................................................................
M3_rs_kh5      ........................................................................................................................
M3_rs_kh6      ........................................................................................................................
M3_rs_kh7      ........................................................................................................................
M3_rs_kh8      ........................................................................................................................
M3_rs_kh9      ........................................................................................................................
M3_rs_kh10     ........................................................................................................................
M3_rs_kh11     ........................................................................................................................
M3_rs_kh12     ........................................................................................................................
M3_rs_kh13     ........................................................................................................................
M3_rs_kh14     ........................................................................................................................
M3_rs_kh15     ........................................................................................................................
M3_rs_kh16     ........................................................................................................................
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M3_rs_kh18     ........................................................................................................................
M3_rs_kh19     ........................................................................................................................
M3_rs_kh20     ........................................................................................................................
M3_rs_kh21     ........................................................................................................................
M3_rs_kh22     ........................................................................................................................
M3_rs_kh23     ........................................................................................................................
M3_rs_kh24     ........................................................................................................................
M3_rs_kh25     ........................................................................................................................
M3_rs_kh26     ........................................................................................................................
M3_rs_kh27     ........................................................................................................................
M3_rs_kh28     ........................................................................................................................
M3_rs_kh29     ........................................................................................................................
M3_rs_kh30     ........................................................................................................................
M3_rs_kh31     ........................................................................................................................
M4_rs_kh32     ........................................................................................................................
M5_rs_ot1      ........................................................................................................................
M6_rs_ri1      ................................................................................................................A.......
M6_rs_ri2      ........................................................................................................................
M7_cn_hj1      ........................................................................................................................
M8_cn_hj2      ........................................................................................................................
M8_cn_hj3      ........................................................................................................................
M8_cn_hj4      ........................................................................................................................
M9_cn_hj5      ........................................................................................................................
M10_cn_nm1     ........................................................................................................................
M11_cn_ul1     ........................................................................................................................
M12_cn_sb1     ........................................................................................................................
M12_cn_sb2     ........................................................................................................................
M13_kr_od1     ........................................................................................................................
M14_kr_jm1     ........................................................................................................................
M14_kr_jm2     ........................................................................................................................
M14_kr_jm3     ........................................................................................................................
M15_kr_dg1     ........................................................................................................................
M16_kr_dr1     ........................................................................................................................
M17_kr_sw1     ........................................................................................................................
M17_kr_sw2     ........................................................................................................................
M18_kr_hg1     ........................................................................................................................
M19_kr_gy1     ........................................................................................................................
M20_kr_nh1     ........................................................................................................................
M20_kr_nh2     ........................................................................................................................
M21_kr_gu1     ........................................................................................................................
M22_kr_mp1     ........................................................................................................................
M23_kr_bc1     ........................................................................................................................
M24_kr_os1     ........................................................................................................................
M25_kr_os2     ........................................................................................................................
M25_kr_os3     ................................................................................................................A.......
M25_kr_os4     ........................................................................................................................
M25_kr_os5     ........................................................................................................................
M26_kr_sn1     ........................................................................................................................
M27_kr_gn1     ........................................................................................................................
M27_kr_gn2     ........................................................................................................................
M28_kr_bs1     ........................................................................................................................
M28_kr_bs2     ........................................................................................................................
M28_kr_bs3     ........................................................................................................................
M29_kr_jn1     ........................................................................................................................
M30_kr_bl1     ........................................................................................................................
M30_kr_bl2     ........................................................................................................................
M31_kr_jl1     ........................................................................................................................
M31_kr_jl2     ........................................................................................................................
M32_kr_mt1     ........................................................................................................................
M33_kr_md1     ........................................................................................................................
M33_kr_md2     ........................................................................................................................
```

Appendix 2. (Continued).

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                                                                                                                                  2640
A1_kr_gr1      TCCTATTTCGGCTCTTATACATGCTGCTACTATGGTAGCAGCGGGTATTTTTCTTGTCGCTAGACTTTTTCCTCTTTTGGTAGTCATCCCCTCCATACTCAATCTAATCGCTTTAATAGG
M34_kr_dn1     ........................................................................................................................
M34_kr_dn2     ........................................................................................................................
M35_kr_sm1     ........................................................................................................................
M35_kr_sm2     ........................................................................................................................
P1_rs_ms1      ........................................................................................................................
P1_rs_ms2      ........................................................................................................................
P1_rs_ms3      ........................................................................................................................
P1_rs_ms4      ........................................................................................................................
P2_rs_nk1      ........................................................................................................................
P2_rs_nk2      ........................................................................................................................
P3_rs_pr1      ........................................................................................................................
P4_rs_pr2      ........................................................................................................................
P4_rs_pr3      ................................................................................................................A.......
P5_rs_rc1      ........................................................................................................................
P5_rs_rc2      ........................................................................................................................
P5_rs_rc3      ........................................................................................................................
P6_rs_rc4      ........................................................................................................................
P6_rs_rc5      ........................................................................................................................
P6_rs_rc6      ........................................................................................................................
P6_rs_rc7      ........................................................................................................................
P6_rs_rc8      ........................................................................................................................
P7_rs_us1      ........................................................................................................................
P7_rs_us2      ........................................................................................................................
P8_rs_pr4      ........................................................................................................................
P9_rs_pr5      ........................................................................................................................
P10_cn_jl1     ........................................................................................................................
P10_cn_jl2     ........................................................................................................................
P11_cn_jl3     ........................................................................................................................
P11_cn_jl4     ........................................................................................................................
P12_cn_sn1     ........................................................................................................................
P12_cn_sn2     ........................................................................................................................
P13_cn_mc1     ........................................................................................................................
P13_cn_mc2     ........................................................................................................................
P14_kr_hw1     ........................................................................................................................
P14_kr_hw2     ........................................................................................................................
P15_kr_dm1     ........................................................................................................................
P15_kr_dm2     ........................................................................................................................
P15_kr_dm3     ........................................................................................................................
P16_kr_sk1     ........................................................................................................................
P16_kr_sk2     ........................................................................................................................
P16_kr_sk3     ........................................................................................................................
P16_kr_sk4     ........................................................................................................................
P16_kr_sk5     ........................................................................................................................
P16_kr_sk6     ........................................................................................................................
P16_kr_sk7     ........................................................................................................................
P16_kr_sk8     ........................................................................................................................
P17_kr_sh1     ........................................................................................................................
P18_kr_gb1     ........................................................................................................................
P19_kr_gw1     ........................................................................................................................
P19_kr_gw2     ........................................................................................................................
P19_kr_gw3     ........................................................................................................................
P20_kr_ck1     ........................................................................................................................
P20_kr_ck2     ........................................................................................................................
P21_kr_hc1     ........................................................................................................................
P22_kr_hb1     ........................................................................................................................
P23_kr_hb2     ........................................................................................................................
P24_kr_mh1     ........................................................................................................................
P24_kr_mh2     ........................................................................................................................
p25_kr_tb1     ........................................................................................................................
p25_kr_tb2     ........................................................................................................................
P26_kr_tb3     ........................................................................................................................
P27_kr_so1     ........................................................................................................................
P27_kr_so2     ........................................................................................................................
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P27_kr_so4     ........................................................................................................................
P27_kr_so5     ........................................................................................................................
P27_kr_so6     ........................................................................................................................
P28_kr_il1     ........................................................................................................................
P29_kr_mj1     ........................................................................................................................
P29_kr_mj2     ........................................................................................................................
P30_kr_dk1     ........................................................................................................................
P31_kr_jr1     ........................................................................................................................
P32_kr_jr2     ........................................................................................................................
O1_jp_rb1      ........................................................................................................................
O2_jp_hk1      ........................................................................................................................
O2_jp_hk2      ........................................................................................................................
O2_jp_hk3      ........................................................................................................................
O2_jp_hk4      ........................................................................................................................
J1_jp_hn1      ........................................................................................................................
J1_jp_hn2      ........................................................................................................................
J2_jp_ky1      ........................................................................................................................
J3_jp_jp1      ........................................................................................................................
B1_cn_bj1      ........................................................................................................................
B2_uk_1        ........................................................................................................................
AMP_cn_1       ..............................C......................................C.........A........................................
SUF_kr_hl1     ...............................................................................A........................................
SUF_kr_hl2     ...............................................................................A........................................
```

Appendix 2. (Continued).

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                                                                                                                                   2760
A1_kr_gr1      TATAATAACAGTACTTTTAGGGGCTACTTTAGCTCTTGCTCAAAAAGACATTAAGAGAAGTTTAGCTTATTCTACAATGTCTCAATTGGGGTATATGATGTTAGCTCTAGGTATGGGGTC
A1_kr_gr2      ........................................................................................................................
A2_kr_hl1      ........................................................................................................................
A2_kr_hl2      ........................................................................................................................
A2_kr_hl3      ........................................................................................................................
A2_kr_hl4      ........................................................................................................................
A3_kr_hl5      ........................................................................................................................
A3_kr_hl6      ........................................................................................................................
A3_kr_hl7      ........................................................................................................................
A3_kr_hl8      ........................................................................................................................
A4_kr_hl9      ........................................................................................................................
A5_kr_hl10     ........................................................................................................................
A5_kr_hl11     ........................................................................................................................
A5_kr_hl12     ........................................................................................................................
A5_kr_hl13     ........................................................................................................................
A5_kr_hl14     ........................................................................................................................
A7_mn_1        ........................................................................................................................
A8_mn_2        ........................................................................................................................
M1_rs_kb1      ........................................................................................................................
M2_rs_kh1      ........................................................................................................................
M2_rs_kh2      ........................................................................................................................
M2_rs_kh3      ........................................................................................................................
M3_rs_kh4      ........................................................................................................................
M3_rs_kh5      ........................................................................................................................
M3_rs_kh6      ........................................................................................................................
M3_rs_kh7      ........................................................................................................................
M3_rs_kh8      ........................................................................................................................
M3_rs_kh9      ........................................................................................................................
M3_rs_kh10     ........................................................................................................................
M3_rs_kh11     ........................................................................................................................
M3_rs_kh12     ........................................................................................................................
M3_rs_kh13     ........................................................................................................................
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M3_rs_kh18     ........................................................................................................................
M3_rs_kh19     ........................................................................................................................
M3_rs_kh20     ........................................................................................................................
M3_rs_kh21     ........................................................................................................................
M3_rs_kh22     ........................................................................................................................
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M3_rs_kh24     ........................................................................................................................
M3_rs_kh25     ........................................................................................................................
M3_rs_kh26     ........................................................................................................................
M3_rs_kh27     ........................................................................................................................
M3_rs_kh28     ........................................................................................................................
M3_rs_kh29     ........................................................................................................................
M3_rs_kh30     ........................................................................................................................
M3_rs_kh31     ........................................................................................................................
M4_rs_kh32     ........................................................................................................................
M5_rs_ot1      ........................................................................................................................
M6_rs_ri1      ........................................................................................................................
M6_rs_ri2      ........................................................................................................................
M7_cn_hj1      ........................................................................................................................
M8_cn_hj2      ........................................................................................................................
M8_cn_hj3      ........................................................................................................................
M8_cn_hj4      ........................................................................................................................
M9_cn_hj5      ............C...........................................................................................................
M10_cn_nm1     ........................................................................................................................
M11_cn_ul1     ........................................................................................................................
M12_cn_sb1     ........................................................................................................................
M12_cn_sb2     ........................................................................................................................
M13_kr_od1     ........................................................................................................................
M14_kr_jm1     ........................................................................................................................
M14_kr_jm2     ........................................................................................................................
M14_kr_jm3     ........................................................................................................................
M15_kr_dg1     ........................................................................................................................
M16_kr_dr1     ........................................................................................................................
M17_kr_sw1     ........................................................................................................................
M17_kr_sw2     ........................................................................................................................
M18_kr_hg1     ........................................................................................................................
M19_kr_gy1     ........................................................................................................................
M20_kr_nh1     ........................................................................................................................
M20_kr_nh2     ........................................................................................................................
M21_kr_gu1     ........................................................................................................................
M22_kr_mp1     ........................................................................................................................
M23_kr_bc1     ........................................................................................................................
M24_kr_os1     ........................................................................................................................
M25_kr_os2     ........................................................................................................................
M25_kr_os3     ........................................................................................................................
M25_kr_os4     ........................................................................................................................
M25_kr_os5     ........................................................................................................................
M26_kr_sn1     ........................................................................................................................
M27_kr_gn1     ........................................................................................................................
M27_kr_gn2     ........................................................................................................................
M28_kr_bs1     ........................................................................................................................
M28_kr_bs2     ........................................................................................................................
M28_kr_bs3     ........................................................................................................................
M29_kr_jn1     ........................................................................................................................
M30_kr_bl1     ........................................................................................................................
M30_kr_bl2     ........................................................................................................................
M31_kr_jl1     ........................................................................................................................
M31_kr_jl2     ........................................................................................................................
M32_kr_mt1     ........................................................................................................................
M33_kr_md1     ........................................................................................................................
M33_kr_md2     ........................................................................................................................
```

Appendix 2. (Continued).

```
                                                                                                                                   2760
A1_kr_gr1      TATAATAACAGTACTTTTAGGGGCTACTTTAGCTCTTGCTCAAAAAGACATTAAGAGAAGTTTAGCTTATTCTACAATGTCTCAATTGGGGTATATGATGTTAGCTCTAGGTATGGGGTC
M34_kr_dn1     ........................................................................................................................
M34_kr_dn2     ........................................................................................................................
P1_rs_ms1      ........................................................................................................................
P1_rs_ms2      ........................................................................................................................
P1_rs_ms3      ........................................................................................................................
P1_rs_ms4      ........................................................................................................................
P2_rs_nk1      ........................................................................................................................
P2_rs_nk2      ........................................................................................................................
P3_rs_pr1      ........................................................................................................................
P4_rs_pr2      ........................................................................................................................
P4_rs_pr3      ........................................................................................................................
P5_rs_rc1      ........................................................................................................................
P5_rs_rc2      ........................................................................................................................
P5_rs_rc3      ........................................................................................................................
P6_rs_rc4      ........................................................................................................................
P6_rs_rc5      ........................................................................................................................
P6_rs_rc6      ........................................................................................................................
P6_rs_rc7      ........................................................................................................................
P6_rs_rc8      ........................................................................................................................
P7_rs_us1      ........................................................................................................................
P7_rs_us2      ........................................................................................................................
P8_rs_pr4      ........................................................................................................................
P9_rs_pr5      ........................................................................................................................
P10_cn_jl1     ........................................................................................................................
P10_cn_jl2     ........................................................................................................................
P11_cn_jl3     ........................................................................................................................
P11_cn_jl4     ........................................................................................................................
P12_cn_sn1     ........................................................................................................................
P12_cn_sn2     ........................................................................................................................
P13_cn_mc1     ........................................................................................................................
P13_cn_mc2     ........................................................................................................................
P14_kr_hw1     ........................................................................................................................
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P15_kr_dm3     ........................................................................................................................
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P16_kr_sk6     ........................................................................................................................
P16_kr_sk7     ........................................................................................................................
P16_kr_sk8     ........................................................................................................................
P17_kr_sh1     ........................................................................................................................
P18_kr_gb1     ........................................................................................................................
P19_kr_gw1     ........................................................................................................................
P19_kr_gw2     ........................................................................................................................
P19_kr_gw3     ........................................................................................................................
P20_kr_ck1     ........................................................................................................................
P20_kr_ck2     ........................................................................................................................
P21_kr_hc1     ........................................................................................................................
P22_kr_hb1     ........................................................................................................................
P23_kr_hb2     ........................................................................................................................
P24_kr_mh1     ........................................................................................................................
P24_kr_mh2     ........................................................................................................................
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P27_kr_so3     ........................................................................................................................
P27_kr_so4     ........................................................................................................................
P27_kr_so5     ........................................................................................................................
P27_kr_so6     ........................................................................................................................
P28_kr_il1     ........................................................................................................................
P29_kr_mj1     ........................................................................................................................
P29_kr_mj2     ........................................................................................................................
P30_kr_dk1     ........................................................................................................................
P31_kr_jr1     ........................................................................................................................
P32_kr_jr2     ........................................................................................................................
O1_jp_rb1      ........................................................................................................................
O2_jp_hk1      ........................................................................................................................
O2_jp_hk2      ........................................................................................................................
O2_jp_hk3      ........................................................................................................................
O2_jp_hk4      ........................................................................................................................
J1_jp_hn1      ........................................................................................................................
J1_jp_hn2      ........................................................................................................................
J2_jp_ky1      ........................................................................................................................
J3_jp_jp1      ........................................................................................................................
B1_cn_bj1      ........................................................................................................................
B2_uk_1        ........................................................................................................................
AMP_cn_1       ........................................................................................................................
SUF_kr_hl1     ........................................................................................................................
SUF_kr_hl2     ........................................................................................................................
```

Appendix 2. (Continued).

```
                                                                                                                                   2880
A1_kr_gr1      TTATCAAGCTGCTTTATTTCATTTGATTACTCATGCTTACTCAAAAGCATTATTGTTTTTAGGATCTGGATCTATTATTCATTCTATGGAAGCTATTGTTGGGTATTCTCCAGAGAAAAG
A1_kr_gr2      ........................................................................................................................
A2_kr_hl1      ........................................................................................................................
A2_kr_hl2      ........................................................................................................................
A2_kr_hl3      ........................................................................................................................
A2_kr_hl4      ........................................................................................................................
A3_kr_hl5      ........................................................................................................................
A3_kr_hl6      ........................................................................................................................
A3_kr_hl7      ........................................................................................................................
A3_kr_hl8      ........................................................................................................................
A4_kr_hl9      ........................................................................................................................
A5_kr_hl10     ........................................................................................................................
A5_kr_hl11     ........................................................................................................................
A5_kr_hl12     ........................................................................................................................
A5_kr_hl13     ........................................................................................................................
A5_kr_hl14     ........................................................................................................................
A7_mn_1        ........................................................................................................................
A8_mn_2        ........................................................................................................................
M1_rs_kb1      ........................................................................................................................
M2_rs_kh1      ........................................................................................................................
M2_rs_kh2      ........................................................................................................................
M2_rs_kh3      ........................................................................................................................
M3_rs_kh4      ........................................................................................................................
M3_rs_kh5      ........................................................................................................................
M3_rs_kh6      ........................................................................................................................
M3_rs_kh7      ........................................................................................................................
M3_rs_kh8      ........................................................................................................................
M3_rs_kh9      ........................................................................................................................
M3_rs_kh10     ........................................................................................................................
M3_rs_kh11     ........................................................................................................................
M3_rs_kh12     ........................................................................................................................
M3_rs_kh13     ........................................................................................................................
M3_rs_kh14     ........................................................................................................................
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M3_rs_kh18     ........................................................................................................................
M3_rs_kh19     ........................................................................................................................
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M3_rs_kh26     ........................................................................................................................
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M3_rs_kh28     ........................................................................................................................
M3_rs_kh29     ........................................................................................................................
M3_rs_kh30     ........................................................................................................................
M3_rs_kh31     ........................................................................................................................
M4_rs_kh32     ........................................................................................................................
M5_rs_ot1      ........................................................................................................................
M6_rs_ri1      ........................................................................................................................
M6_rs_ri2      ........................................................................................................................
M7_cn_hj1      ........................................................................................................................
M8_cn_hj2      ........................................................................................................................
M8_cn_hj3      ...................................................................................T....................................
M8_cn_hj4      ...................................................................................T....................................
M9_cn_hj5      ...................................................................................T....................................
M10_cn_nm1     ........................................................................................................................
M11_cn_ul1     ...................................................................................T....................................
M12_cn_sb1     ...................................................................................T....................................
M12_cn_sb2     ...................................................................................T....................................
M13_kr_od1     ........................................................................................................................
M14_kr_jm1     ........................................................................................................................
M14_kr_jm2     ........................................................................................................................
M14_kr_jm3     ........................................................................................................................
M15_kr_dg1     ........................................................................................................................
M16_kr_dr1     ........................................................................................................................
M17_kr_sw1     ........................................................................................................................
M17_kr_sw2     ........................................................................................................................
M18_kr_hg1     ........................................................................................................................
M19_kr_gy1     ........................................................................................................................
M20_kr_nh1     ........................................................................................................................
M20_kr_nh2     ........................................................................................................................
M21_kr_gu1     ........................................................................................................................
M22_kr_mp1     ........................................................................................................................
M23_kr_bc1     ........................................................................................................................
M24_kr_os1     ........................................................................................................................
M25_kr_os2     ........................................................................................................................
M25_kr_os3     ........................................................................................................................
M25_kr_os4     ........................................................................................................................
M25_kr_os5     ........................................................................................................................
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M28_kr_bs2     ........................................................................................................................
M28_kr_bs3     ........................................................................................................................
M29_kr_jn1     ........................................................................................................................
M30_kr_bl1     ........................................................................................................................
M30_kr_bl2     ........................................................................................................................
M31_kr_jl1     ........................................................................................................................
M31_kr_jl2     ........................................................................................................................
M32_kr_mt1     ........................................................................................................................
M33_kr_md1     ........................................................................................................................
M33_kr_md2     ........................................................................................................................
```

Appendix 2. (Continued).

```
                                                                                                                                  2880
A1_kr_gr1      TTATCAAGCTGCTTTATTTCATTTGATTACTCATGCTTACTCAAAAGCATTATTGTTTTTAGGATCTGGATCTATTATTCATTCTATGGAAGCTATTGTTGGGTATTCTCCAGAGAAAAG
M34_kr_dn1     ........................................................................................................................
M34_kr_dn2     ........................................................................................................................
M35_kr_sm1     ........................................................................................................................
M35_kr_sm2     ........................................................................................................................
P1_rs_ms1      ........................................................................................................................
P1_rs_ms2      ........................................................................................................................
P1_rs_ms3      ........................................................................................................................
P1_rs_ms4      ........................................................................................................................
P2_rs_nk1      ........................................................................................................................
P2_rs_nk2      ........................................................................................................................
P3_rs_pr1      ........................................................................................................................
P4_rs_pr2      ........................................................................................................................
P4_rs_pr3      ........................................................................................................................
P5_rs_rc1      ........................................................................................................................
P5_rs_rc2      ........................................................................................................................
P5_rs_rc3      ........................................................................................................................
P6_rs_rc4      ........................................................................................................................
P6_rs_rc5      ........................................................................................................................
P6_rs_rc6      ........................................................................................................................
P6_rs_rc7      ........................................................................................................................
P6_rs_rc8      ........................................................................................................................
P7_rs_us1      ........................................................................................................................
P7_rs_us2      ........................................................................................................................
P8_rs_pr4      ........................................................................................................................
P9_rs_pr5      ........................................................................................................................
P10_cn_jl1     ...................................................................................T....................................
P10_cn_jl2     ...................................................................................T....................................
P11_cn_jl3     ...................................................................................T....................................
P11_cn_jl4     ...................................................................................T....................................
P12_cn_sn1     ...................................................................................T....................................
P12_cn_sn2     ...................................................................................T....................................
P13_cn_mc1     ...................................................................................T....................................
P13_cn_mc2     ...................................................................................T....................................
P14_kr_hw1     ........................................................................................................................
P14_kr_hw2     ........................................................................................................................
P15_kr_dm1     ........................................................................................................................
P15_kr_dm2     ........................................................................................................................
P15_kr_dm3     ........................................................................................................................
P16_kr_sk1     ...................................................................................T....................................
P16_kr_sk2     ...................................................................................T....................................
P16_kr_sk3     ...................................................................................T....................................
P16_kr_sk4     ...................................................................................T....................................
P16_kr_sk5     ........................................................................................................................
P16_kr_sk6     ...................................................................................T....................................
P16_kr_sk7     ...................................................................................T....................................
P16_kr_sk8     ...................................................................................T....................................
P17_kr_sh1     ........................................................................................................................
P18_kr_gb1     ........................................................................................................................
P19_kr_gw1     ........................................................................................................................
P19_kr_gw2     ........................................................................................................................
P19_kr_gw3     ........................................................................................................................
P20_kr_ck1     ........................................................................................................................
P20_kr_ck2     ........................................................................................................................
P21_kr_hc1     ........................................................................................................................
P22_kr_hb1     ........................................................................................................................
P23_kr_hb2     ........................................................................................................................
P24_kr_mh1     ................................................................................C.......................................
P24_kr_mh2     ........................................................................................................................
p25_kr_tb1     ........................................................................................................................
p25_kr_tb2     ........................................................................................................................
P26_kr_tb3     ........................................................................................................................
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P27_kr_so2     ........................................................................................................................
P27_kr_so3     ........................................................................................................................
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P27_kr_so5     ........................................................................................................................
P27_kr_so6     ........................................................................................................................
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P29_kr_mj1     ........................................................................................................................
P29_kr_mj2     ........................................................................................................................
P30_kr_dk1     ........................................................................................................................
P31_kr_jr1     ........................................................................................................................
O1_jp_rb1      ........................................................................................................................
O2_jp_hk1      ........................................................................................................................
O2_jp_hk2      ........................................................................................................................
O2_jp_hk3      ........................................................................................................................
O2_jp_hk4      ........................................................................................................................
J1_jp_hn1      ........................................................................................................................
J1_jp_hn2      ........................................................................................................................
J2_jp_ky1      ........................................................................................................................
J3_jp_jp1      ........................................................................................................................
B1_cn_bj1      ........................................................................................................................
B2_uk_1        ........................................................................................................................
AMP_cn_1       ........................................................................................................................
SUF_kr_hl1     ........................................................................................................................
SUF_kr_hl2     ........................................................................................................................
```

Appendix 2. (Continued).

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                                                                                                                                    3000
A1_kr_gr1       CCAGAATATGGTTTTTATGGGGGGGTTAAAAAAGCACGCGCCAATTACAAAAACTGCTTTTTTTTTAGGTACACTTTCTCTTTCTGGTATTCCGCCTCTTGCTTGTTTTTGGTCCAAAGA
A1_kr_gr2       ........................................................................................................................
A2_kr_hl1       ........................................................................................................................
A2_kr_hl2       ........................................................................................................................
A2_kr_hl3       ........................................................................................................................
A2_kr_hl4       ........................................................................................................................
A3_kr_hl5       ........................................................................................................................
A3_kr_hl6       ........................................................................................................................
A3_kr_hl7       ........................................................................................................................
A3_kr_hl8       ........................................................................................................................
A4_kr_hl9       ........................................................................................................................
A5_kr_hl10      ........................................................................................................................
A5_kr_hl11      ........................................................................................................................
A5_kr_hl12      ........................................................................................................................
A5_kr_hl13      ........................................................................................................................
A5_kr_hl14      ........................................................................................................................
A7_mn_1         ........................................................................................................................
A8_mn_2         ........................................................................................................................
M1_rs_kb1       ........................................................................................................................
M2_rs_kh1       ........................................................................................................................
M2_rs_kh2       ........................................................................................................................
M2_rs_kh3       ........................................................................................................................
M3_rs_kh4       ........................................................................................................................
M3_rs_kh5       ........................................................................................................................
M3_rs_kh6       ........................................................................................................................
M3_rs_kh7       ........................................................................................................................
M3_rs_kh8       ........................................................................................................................
M3_rs_kh9       ........................................................................................................................
M3_rs_kh10      ........................................................................................................................
M3_rs_kh11      ........................................................................................................................
M3_rs_kh12      ........................................................................................................................
M3_rs_kh13      ........................................................................................................................
M3_rs_kh14      ........................................................................................................................
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M3_rs_kh20      ........................................................................................................................
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M3_rs_kh31      ........................................................................................................................
M4_rs_kh32      ........................................................................................................................
M5_rs_ot1       ........................................................................................................................
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M6_rs_ri2       ........................................................................................................................
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M8_cn_hj2       ........................................................................................................................
M8_cn_hj3       ........................................................................................................................
M8_cn_hj4       ........................................................................................................................
M9_cn_hj5       ........................................................................................................................
M10_cn_nm1      ........................................................................................................................
M11_cn_ul1      ........................................................................................................................
M12_cn_sb1      ........................................................................................................................
M12_cn_sb2      ........................................................................................................................
M13_kr_od1      ........................................................................................................................
M14_kr_jm1      ........................................................................................................................
M14_kr_jm2      ........................................................................................................................
M14_kr_jm3      ........................................................................................................................
M15_kr_dg1      ........................................................................................................................
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M17_kr_sw2      ........................................................................................................................
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M20_kr_nh1      ........................................................................................................................
M20_kr_nh2      ........................................................................................................................
M21_kr_gu1      ........................................................................................................................
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M23_kr_bc1      ........................................................................................................................
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M25_kr_os2      ........................................................................................................................
M25_kr_os3      ........................................................................................................................
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M25_kr_os5      ........................................................................................................................
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M27_kr_gn2      ........................................................................................................................
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M28_kr_bs3      ........................................................................................................................
M29_kr_jn1      ........................................................................................................................
M30_kr_bl1      ........................................................................................................................
M30_kr_bl2      ........................................................................................................................
M31_kr_jl1      ........................................................................................................................
M31_kr_jl2      ........................................................................................................................
M32_kr_mt1      ........................................................................................................................
M33_kr_md1      ........................................................................................................................
M33_kr_md2      ........................................................................................................................
```

Appendix 2. (Continued).

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                                                                                                                                   3000
A1_kr_gr1      CCAGAATATGGTTTTTATGGGGGGGTTAAAAAAGCACGCGCCAATTACAAAAACTGCTTTTTTTTTAGGTACACTTTCTCTTTCTGGTATTCCGCCTCTTGCTTGTTTTTGGTCCAAAGA
M34_kr_dn1     ........................................................................................................................
M34_kr_dn2     ........................................................................................................................
M35_kr_sm1     ........................................................................................................................
M35_kr_sm2     ........................................................................................................................
P1_rs_ms1      ........................................................................................................................
P1_rs_ms2      ........................................................................................................................
P1_rs_ms3      ........................................................................................................................
P1_rs_ms4      ........................................................................................................................
P2_rs_nk1      ........................................................................................................................
P2_rs_nk2      ........................................................................................................................
P3_rs_pr1      ........................................................................................................................
P4_rs_pr2      ........................................................................................................................
P4_rs_pr3      ........................................................................................................................
P5_rs_rc1      ........................................................................................................................
P5_rs_rc2      ........................................................................................................................
P5_rs_rc3      ........................................................................................................................
P6_rs_rc4      ........................................................................................................................
P6_rs_rc5      ........................................................................................................................
P6_rs_rc6      ........................................................................................................................
P6_rs_rc7      ........................................................................................................................
P6_rs_rc8      ........................................................................................................................
P7_rs_us1      ........................................................................................................................
P7_rs_us2      ........................................................................................................................
P8_rs_pr4      ........................................................................................................................
P9_rs_pr5      ........................................................................................................................
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P10_cn_jl2     ........................................................................................................................
P11_cn_jl3     ........................................................................................................................
P11_cn_jl4     ........................................................................................................................
P12_cn_sn1     ........................................................................................................................
P12_cn_sn2     ........................................................................................................................
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P16_kr_sk7     ........................................................................................................................
P16_kr_sk8     ........................................................................................................................
P17_kr_sh1     ........................................................................................................................
P18_kr_gb1     ........................................................................................................................
P19_kr_gw1     ........................................................................................................................
P19_kr_gw2     ........................................................................................................................
P19_kr_gw3     ........................................................................................................................
P20_kr_ck1     ........................................................................................................................
P20_kr_ck2     ........................................................................................................................
P21_kr_hc1     ........................................................................................................................
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P23_kr_hb2     ........................................................................................................................
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p25_kr_tb2     ........................................................................................................................
P26_kr_tb3     ........................................................................................................................
P27_kr_so1     ........................................................................................................................
P27_kr_so2     ........................................................................................................................
P27_kr_so3     ........................................................................................................................
P27_kr_so4     ........................................................................................................................
P27_kr_so5     ........................................................................................................................
P27_kr_so6     ........................................................................................................................
P28_kr_il1     ........................................................................................................................
P29_kr_mj1     ........................................................................................................................
P29_kr_mj2     ........................................................................................................................
P30_kr_dk1     ........................................................................................................................
P31_kr_jr1     ........................................................................................................................
O1_jp_rb1      ........................................................................................................................
O2_jp_hk1      ........................................................................................................................
O2_jp_hk2      ........................................................................................................................
O2_jp_hk3      ........................................................................................................................
O2_jp_hk4      ........................................................................................................................
J1_jp_hn1      ........................................................................................................................
J1_jp_hn2      ........................................................................................................................
J2_jp_ky1      ........................................................................................................................
J3_jp_jp1      ........................................................................................................................
B1_cn_bj1      ........................................................................................................................
B2_uk_1        ........................................................................................................................
AMP_cn_1       ........................................................................................................................
SUF_kr_hl1     ......................................................................................................G.................
SUF_kr_hl2     ......................................................................................................G.................
```

Appendix 2. (Continued).

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                                                                                                                                   3120
A1_kr_gr1      TGAAATTCTTAATGATAGTTGGTTGTATTCACCAATTTTCGCAAGCATATCCTGGGCTACAGCAGCATTAACTGCATTTTATATGTTTCGCATCTATTTACTTACGTTTGAGGGTCATTT
A1_kr_gr2      ........................................................................................................................
A2_kr_hl1      ........................................................................................................................
A2_kr_hl2      ........................................................................................................................
A2_kr_hl3      ........................................................................................................................
A2_kr_hl4      ........................................................................................................................
A3_kr_hl5      ........................................................................................................................
A3_kr_hl6      ........................................................................................................................
A3_kr_hl7      ........................................................................................................................
A3_kr_hl8      ........................................................................................................................
A4_kr_hl9      ........................................................................................................................
A5_kr_hl10     ........................................................................................................................
A5_kr_hl11     ........................................................................................................................
A5_kr_hl12     ........................................................................................................................
A5_kr_hl13     ........................................................................................................................
A5_kr_hl14     ........................................................................................................................
A7_mn_1        ........................................................................................................................
A8_mn_2        ........................................................................................................................
M1_rs_kb1      ........................................................................................................................
M2_rs_kh1      ........................................................................................................................
M2_rs_kh2      ........................................................................................................................
M2_rs_kh3      ........................................................................................................................
M3_rs_kh4      ........................................................................................................................
M3_rs_kh5      ........................................................................................................................
M3_rs_kh6      ........................................................................................................................
M3_rs_kh7      ........................................................................................................................
M3_rs_kh8      ........................................................................................................................
M3_rs_kh9      ........................................................................................................................
M3_rs_kh10     ........................................................................................................................
M3_rs_kh11     ........................................................................................................................
M3_rs_kh12     ........................................................................................................................
M3_rs_kh13     ........................................................................................................................
M3_rs_kh14     ........................................................................................................................
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M3_rs_kh16     ........................................................................................................................
M3_rs_kh17     ........................................................................................................................
M3_rs_kh18     ........................................................................................................................
M3_rs_kh19     ........................................................................................................................
M3_rs_kh20     ........................................................................................................................
M3_rs_kh21     ........................................................................................................................
M3_rs_kh22     ........................................................................................................................
M3_rs_kh23     ........................................................................................................................
M3_rs_kh24     ........................................................................................................................
M3_rs_kh25     ........................................................................................................................
M3_rs_kh26     ........................................................................................................................
M3_rs_kh27     ........................................................................................................................
M3_rs_kh28     ........................................................................................................................
M3_rs_kh29     ........................................................................................................................
M3_rs_kh30     ........................................................................................................................
M3_rs_kh31     ........................................................................................................................
M4_rs_kh32     ........................................................................................................................
M5_rs_ot1      ........................................................................................................................
M6_rs_ri1      ..............................................................T.........................................................
M6_rs_ri2      ........................................................................................................................
M7_cn_hj1      ........................................................................................................................
M8_cn_hj3      ........................................................................................................................
M8_cn_hj2      .........................................................................................................A..............
M8_cn_hj4      ........................................................................................................................
M9_cn_hj5      ........................................................................................................................
M10_cn_nm1     ........................................................................................................................
M11_cn_ul1     ........................................................................................................................
M12_cn_sb1     ........................................................................................................................
M12_cn_sb2     ........................................................................................................................
M13_kr_od1     ........................................................................................................................
M14_kr_jm1     ........................................................................................................................
M14_kr_jm2     ........................................................................................................................
M14_kr_jm3     ........................................................................................................................
M15_kr_dg1     ........................................................................................................................
M16_kr_dr1     ........................................................................................................................
M17_kr_sw1     ........................................................................................................................
M17_kr_sw2     ........................................................................................................................
M18_kr_hg1     ........................................................................................................................
M19_kr_gy1     ........................................................................................................................
M20_kr_nh1     ........................................................................................................................
M20_kr_nh2     ........................................................................................................................
M21_kr_gu1     ........................................................................................................................
M22_kr_mp1     ........................................................................................................................
M23_kr_bc1     ........................................................................................................................
M24_kr_os1     ........................................................................................................................
M25_kr_os2     ........................................................................................................................
M25_kr_os3     ..............................................................T.........................................................
M25_kr_os4     ........................................................................................................................
M25_kr_os5     ........................................................................................................................
M26_kr_sn1     ........................................................................................................................
M27_kr_gn1     ........................................................................................................................
M27_kr_gn2     ........................................................................................................................
M28_kr_bs1     ........................................................................................................................
M28_kr_bs2     ........................................................................................................................
M28_kr_bs3     ........................................................................................................................
M29_kr_jn1     ........................................................................................................................
M30_kr_bl1     ........................................................................................................................
M30_kr_bl2     ........................................................................................................................
M31_kr_jl1     ........................................................................................................................
M31_kr_jl2     ........................................................................................................................
M32_kr_mt1     ........................................................................................................................
M33_kr_md1     ........................................................................................................................
M33_kr_md2     ........................................................................................................................
```

Appendix 2. (Continued).

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                                                                                                                                   3120
A1_kr_gr1      TGAAATTCTTAATGATAGTTGGTTGTATTCACCAATTTTCGCAAGCATATCCTGGGCTACAGCAGCATTAACTGCATTTTATATGTTTCGCATCTATTTACTTACGTTTGAGGGTCATTT
M34_kr_dn1     ........................................................................................................................
M34_kr_dn2     ........................................................................................................................
M35_kr_sm1     ........................................................................................................................
M35_kr_sm2     ........................................................................................................................
P1_rs_ms1      ........................................................................................................................
P1_rs_ms2      ........................................................................................................................
P1_rs_ms3      ........................................................................................................................
P1_rs_ms4      ........................................................................................................................
P2_rs_nk1      .......................................................................................................................
P2_rs_nk2      ........................................................................................................................
P3_rs_pr1      ........................................................................................................................
P4_rs_pr2      ........................................................................................................................
P4_rs_pr3      ..............................................................T.........................................................
P5_rs_rc1      ........................................................................................................................
P5_rs_rc2      ........................................................................................................................
P5_rs_rc3      ........................................................................................................................
P6_rs_rc4      ........................................................................................................................
P6_rs_rc5      ........................................................................................................................
P6_rs_rc6      ........................................................................................................................
P6_rs_rc7      ........................................................................................................................
P6_rs_rc8      ........................................................................................................................
P7_rs_us1      ........................................................................................................................
P7_rs_us2      ........................................................................................................................
P8_rs_pr4      ........................................................................................................................
P9_rs_pr5      ........................................................................................................................
P10_cn_jl1     ........................................................................................................................
P10_cn_jl2     ........................................................................................................................
P11_cn_jl3     ........................................................................................................................
P11_cn_jl4     ........................................................................................................................
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P12_cn_sn2     ........................................................................................................................
P13_cn_mc1     ........................................................................................................................
P13_cn_mc2     ........................................................................................................................
P14_kr_hw1     ........................................................................................................................
P14_kr_hw2     ........................................................................................................................
P15_kr_dm1     ........................................................................................................................
P15_kr_dm2     ........................................................................................................................
P15_kr_dm3     ........................................................................................................................
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P16_kr_sk8     ........................................................................................................................
P17_kr_sh1     ........................................................................................................................
P18_kr_gb1     ........................................................................................................................
P19_kr_gw1     ........................................................................................................................
P19_kr_gw2     ........................................................................................................................
P19_kr_gw3     ........................................................................................................................
P20_kr_ck1     ........................................................................................................................
P20_kr_ck2     ........................................................................................................................
P21_kr_hc1     ........................................................................................................................
P22_kr_hb1     ........................................................................................................................
P23_kr_hb2     ........................................................................................................................
P24_kr_mh1     ........................................................................................................................
P24_kr_mh2     ........................................................................................................................
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P27_kr_so5     ........................................................................................................................
P27_kr_so6     ........................................................................................................................
P28_kr_il1     ........................................................................................................................
P29_kr_mj1     ........................................................................................................................
P29_kr_mj2     ........................................................................................................................
P30_kr_dk1     ........................................................................................................................
P31_kr_jr1     ........................................................................................................................
O1_jp_rb1      ........................................................................................................................
O2_jp_hk1      ........................................................................................................................
O2_jp_hk2      ........................................................................................................................
O2_jp_hk3      ........................................................................................................................
O2_jp_hk4      ........................................................................................................................
J1_jp_hn1      ........................................................................................................................
J1_jp_hn2      ........................................................................................................................
J2_jp_ky1      ........................................................................................................................
J3_jp_jp1      ........................................................................................................................
B1_cn_bj1      ........................................................................................................................
B2_uk_1        ........................................................................................................................
AMP_cn_1       C.......................................................................................................................
SUF_kr_hl1     .............A...................................G......................................................................
SUF_kr_hl2     .............A...................................G......................................................................
```

Appendix 2. (Continued).

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                                                                                                                                   3240
A1_kr_gr1      AAATGTTCAGTTTCAAAATTACAATGGAAAAAAAAGTAGTTCCTTCTATTCAATATCCTTATGGGGCCAAGAGGGACTAAAACCTATTAACAAAAATTTTAGTTTATTAACTTTCTTGCC
A1_kr_gr2      ........................................................................................................................
A2_kr_hl1      ........................................................................................................................
A2_kr_hl2      ........................................................................................................................
A2_kr_hl3      ........................................................................................................................
A2_kr_hl4      ...............................................................................................T........................
A3_kr_hl5      ........................................................................................................................
A3_kr_hl6      ........................................................................................................................
A3_kr_hl7      ........................................................................................................................
A3_kr_hl8      ........................................................................................................................
A4_kr_hl9      ........................................................................................................................
A5_kr_hl10     ........................................................................................................................
A5_kr_hl11     ........................................................................................................................
A5_kr_hl12     ........................................................................................................................
A5_kr_hl13     ........................................................................................................................
A5_kr_hl14     ........................................................................................................................
A7_mn_1        ........................................................................................................................
A8_mn_2        ........................................................................................................................
M1_rs_kb1      ........................................................................................................................
M2_rs_kh1      ........................................................................................................................
M2_rs_kh2      ........................................................................................................................
M2_rs_kh3      ........................................................................................................................
M3_rs_kh4      ........................................................................................................................
M3_rs_kh5      ........................................................................................................................
M3_rs_kh6      ........................................................................................................................
M3_rs_kh7      ........................................................................................................................
M3_rs_kh8      ........................................................................................................................
M3_rs_kh9      ........................................................................................................................
M3_rs_kh10     ........................................................................................................................
M3_rs_kh11     ........................................................................................................................
M3_rs_kh12     ........................................................................................................................
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M3_rs_kh26     ........................................................................................................................
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M3_rs_kh28     ........................................................................................................................
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M3_rs_kh30     ........................................................................................................................
M3_rs_kh31     ........................................................................................................................
M4_rs_kh32     ........................................................................................................................
M5_rs_ot1      ........................................................................................................................
M6_rs_ri1      ........................................................................................................................
M6_rs_ri2      ........................................................................................................................
M7_cn_hj1      ........................................................................................................................
M8_cn_hj2      ........................................................................................................................
M8_cn_hj3      ........................................................................................................................
M8_cn_hj4      ........................................................................................................................
M9_cn_hj5      ........................................................................................................................
M10_cn_nm1     ........................................................................................................................
M11_cn_ul1     ........................................................................................................................
M12_cn_sb1     ........................................................................................................................
M12_cn_sb2     ........................................................................................................................
M13_kr_od1     ........................................................................................................................
M14_kr_jm1     ........................................................................................................................
M14_kr_jm2     ........................................................................................................................
M14_kr_jm3     ........................................................................................................................
M15_kr_dg1     ........................................................................................................................
M16_kr_dr1     ........................................................................................................................
M17_kr_sw1     ........................................................................................................................
M17_kr_sw2     ........................................................................................................................
M18_kr_hg1     ........................................................................................................................
M19_kr_gy1     ........................................................................................................................
M20_kr_nh1     ........................................................................................................................
M20_kr_nh2     ........................................................................................................................
M21_kr_gu1     ........................................................................................................................
M22_kr_mp1     ........................................................................................................................
M23_kr_bc1     ........................................................................................................................
M24_kr_os1     ........................................................................................................................
M25_kr_os2     ........................................................................................................................
M25_kr_os3     ........................................................................................................................
M25_kr_os4     ........................................................................................................................
M25_kr_os5     ........................................................................................................................
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M27_kr_gn1     ........................................................................................................................
M27_kr_gn2     ........................................................................................................................
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M28_kr_bs2     ........................................................................................................................
M28_kr_bs3     ........................................................................................................................
M29_kr_jn1     ........................................................................................................................
M30_kr_bl1     ........................................................................................................................
M30_kr_bl2     ........................................................................................................................
M31_kr_jl1     ........................................................................................................................
M31_kr_jl2     ........................................................................................................................
M32_kr_mt1     ........................................................................................................................
M33_kr_md1     ........................................................................................................................
M33_kr_md2     ........................................................................................................................
```

Appendix 2. (Continued).

```
                                                                                                                                  3240
A1_kr_gr1      AAATGTTCAGTTTCAAAATTACAATGGAAAAAAAAGTAGTTCCTTCTATTCAATATCCTTATGGGGCCAAGAGGGACTAAAACCTATTAACAAAAATTTTAGTTTATTAACTTTCTTGCC
M34_kr_dn1     ........................................................................................................................
M34_kr_dn2     ........................................................................................................................
M35_kr_sm1     ........................................................................................................................
M35_kr_sm2     ........................................................................................................................
P1_rs_ms1      ........................................................................................................................
P1_rs_ms2      ........................................................................................................................
P1_rs_ms3      ........................................................................................................................
P1_rs_ms4      ........................................................................................................................
P2_rs_nk1      ........................................................................................................................
P2_rs_nk2      ........................................................................................................................
P3_rs_pr1      ........................................................................................................................
P4_rs_pr2      ........................................................................................................................
P4_rs_pr3      ........................................................................................................................
P5_rs_rc1      ........................................................................................................................
P5_rs_rc2      ........................................................................................................................
P5_rs_rc3      ........................................................................................................................
P6_rs_rc4      ........................................................................................................................
P6_rs_rc5      ........................................................................................................................
P6_rs_rc6      ........................................................................................................................
P6_rs_rc7      ........................................................................................................................
P6_rs_rc8      ........................................................................................................................
P7_rs_us1      ........................................................................................................................
P7_rs_us2      ........................................................................................................................
P8_rs_pr4      ........................................................................................................................
P9_rs_pr5      ........................................................................................................................
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P10_cn_jl2     ........................................................................................................................
P11_cn_jl3     ........................................................................................................................
P11_cn_jl4     ........................................................................................................................
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P19_kr_gw1     ........................................................................................................................
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P19_kr_gw3     ........................................................................................................................
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P24_kr_mh2     ........................................................................................................................
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P27_kr_so2     ........................................................................................................................
P27_kr_so3     ........................................................................................................................
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P27_kr_so5     ........................................................................................................................
P27_kr_so6     ........................................................................................................................
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P29_kr_mj1     ........................................................................................................................
P29_kr_mj2     ........................................................................................................................
P30_kr_dk1     ........................................................................................................................
P31_kr_jr1     ........................................................................................................................
O1_jp_rb1      ........................................................................................................................
O2_jp_hk1      ........................................................................................................................
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O2_jp_hk3      ........................................................................................................................
O2_jp_hk4      ........................................................................................................................
J1_jp_hn1      ........................................................................................................................
J1_jp_hn2      ........................................................................................................................
J2_jp_ky1      ........................................................................................................................
J3_jp_jp1      ........................................................................................................................
B1_cn_bj1      ........................................................................................................................
B2_uk_1         ........................................................................................................................
AMP_cn_1       ....................................................................................................C...................
SUF_kr_hl1     ............................................................................T.......................C..................A
SUF_kr_hl2     ............................................................................T.......................C..................A
```

Appendix 2. (Continued).

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                                                                                                                                     3360
A1_kr_gr1        AAAAAAAAATAACGAAAGTGTTTCTAAGAATACACACGGAAATATAAAAAAAACGATGCGATCTTGTCTTTTTTTTTATAATTGTGACAATAAAAAATTTTCGACATACCCTCACGAATC
A1_kr_gr2        ........................................................................................................................
A2_kr_hl1        ........................................................................................................................
A2_kr_hl2        ........................................................................................................................
A2_kr_hl3        ........................................................................................................................
A2_kr_hl4        ........................................................................................................................
A3_kr_hl5        ........................................................................................................................
A3_kr_hl6        ........................................................................................................................
A3_kr_hl7        ........................................................................................................................
A3_kr_hl8        ........................................................................................................................
A4_kr_hl9        ........................................................................................................................
A5_kr_hl10       ........................................................................................................................
A5_kr_hl11       ........................................................................................................................
A5_kr_hl12       ........................................................................................................................
A5_kr_hl13       ........................................................................................................................
A5_kr_hl14       ........................................................................................................................
A7_mn_1          ........................................................................................................................
A8_mn_2          ........................................................................................................................
M1_rs_kb1        ........................................................................................................................
M2_rs_kh1        ........................................................................................................................
M2_rs_kh2        ........................................................................................................................
M2_rs_kh3        ........................................................................................................................
M3_rs_kh4        ........................................................................................................................
M3_rs_kh5        ........................................................................................................................
M3_rs_kh6        ........................................................................................................................
M3_rs_kh7        ........................................................................................................................
M3_rs_kh8        ........................................................................................................................
M3_rs_kh9        ........................................................................................................................
M3_rs_kh10       ........................................................................................................................
M3_rs_kh11       ........................................................................................................................
M3_rs_kh12       ........................................................................................................................
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M3_rs_kh30       ........................................................................................................................
M3_rs_kh31       ........................................................................................................................
M4_rs_kh32       ........................................................................................................................
M5_rs_ot1        ........................................................................................................................
M6_rs_ri1        ...............................................................................................................G........
M6_rs_ri2        ........................................................................................................................
M7_cn_hj1        ........................................................................................................................
M8_cn_hj2        ........................................................................................................................
M8_cn_hj3        ........................................................................................................................
M8_cn_hj4        ........................................................................................................................
M9_cn_hj5        ........................................................................................................................
M10_cn_nm1       ........................................................................................................................
M11_cn_ul1       ........................................................................................................................
M12_cn_sb1       ........................................................................................................................
M12_cn_sb2       ........................................................................................................................
M13_kr_od1       ........................................................................................................................
M14_kr_jm1       ........................................................................................................................
M14_kr_jm2       ........................................................................................................................
M14_kr_jm3       ........................................................................................................................
M15_kr_dg1       ........................................................................................................................
M16_kr_dr1       ........................................................................................................................
M17_kr_sw1       ........................................................................................................................
M17_kr_sw2       ........................................................................................................................
M18_kr_hg1       ........................................................................................................................
M19_kr_gy1       ........................................................................................................................
M20_kr_nh1       ........................................................................................................................
M20_kr_nh2       ........................................................................................................................
M21_kr_gu1       ........................................................................................................................
M22_kr_mp1       ........................................................................................................................
M23_kr_bc1       ........................................................................................................................
M24_kr_os1       ........................................................................................................................
M25_kr_os2       ........................................................................................................................
M25_kr_os3       ...............................................................................................................G........
M25_kr_os4       ........................................................................................................................
M25_kr_os5       ............................................A...........................................................................
M26_kr_sn1       ........................................................................................................................
M27_kr_gn1       ........................................................................................................................
M27_kr_gn2       ........................................................................................................................
M28_kr_bs1       ........................................................................................................................
M28_kr_bs2       ........................................................................................................................
M28_kr_bs3       ........................................................................................................................
M29_kr_jn1       ........................................................................................................................
M30_kr_bl1       ........................................................................................................................
M30_kr_bl2       ........................................................................................................................
M31_kr_jl1       ........................................................................................................................
M31_kr_jl2       ........................................................................................................................
M32_kr_mt1       ........................................................................................................................
M33_kr_md1       ........................................................................................................................
M33_kr_md2       ........................................................................................................................
```

Appendix 2. (Continued).

```
                                                                                                                                   3360
A1_kr_gr1      AAAAAAAAATAACGAAAGTGTTTCTAAGAATACACACGGAAATATAAAAAAAACGATGCGATCTTGTCTTTTTTTTTATAATTGTGACAATAAAAAATTTTCGACATACCCTCACGAATC
M34_kr_dn1     ........................................................................................................................
M34_kr_dn2     ........................................................................................................................
M35_kr_sm1     ........................................................................................................................
M35_kr_sm2     ........................................................................................................................
P1_rs_ms1      ........................................................................................................................
P1_rs_ms2      ........................................................................................................................
P1_rs_ms3      ........................................................................................................................
P1_rs_ms4      ........................................................................................................................
P2_rs_nk1      ........................................................................................................................
P2_rs_nk2      ........................................................................................................................
P3_rs_pr1      ........................................................................................................................
P4_rs_pr2      ........................................................................................................................
P4_rs_pr3      ...............................................................................................................G........
P5_rs_rc1      ........................................................................................................................
P5_rs_rc2      ........................................................................................................................
P5_rs_rc3      ........................................................................................................................
P6_rs_rc4      ........................................................................................................................
P6_rs_rc5      ........................................................................................................................
P6_rs_rc6      ........................................................................................................................
P6_rs_rc7      ........................................................................................................................
P6_rs_rc8      ........................................................................................................................
P7_rs_us1      .......................................................................................................................
P7_rs_us2      ........................................................................................................................
P8_rs_pr4      ........................................................................................................................
P9_rs_pr5      ........................................................................................................................
P10_cn_jl1     ........................................................................................................................
P10_cn_jl2     ........................................................................................................................
P11_cn_jl3     ........................................................................................................................
P11_cn_jl4     ........................................................................................................................
P12_cn_sn1     ........................................................................................................................
P12_cn_sn2     ........................................................................................................................
P13_cn_mc1     ........................................................................................................................
P13_cn_mc2     ........................................................................................................................
P14_kr_hw1     ........................................................................................................................
P14_kr_hw2     ........................................................................................................................
P15_kr_dm1     ........................................................................................................................
P15_kr_dm2     ........................................................................................................................
P15_kr_dm3     ........................................................................................................................
P16_kr_sk1     ........................................................................................................................
P16_kr_sk2     ........................................................................................................................
P16_kr_sk3     ........................................................................................................................
P16_kr_sk4     ........................................................................................................................
P16_kr_sk5     ............G...........................................................................................................
P16_kr_sk6     ........................................................................................................................
P16_kr_sk7     ........................................................................................................................
P16_kr_sk8     ........................................................................................................................
P17_kr_sh1     ........................................................................................................................
P18_kr_gb1     ........................................................................................................................
P19_kr_gw1     ............G...........................................................................................................
P19_kr_gw2     ............G...........................................................................................................
P19_kr_gw3     ........................................................................................................................
P20_kr_ck1     ........................................................................................................................
P20_kr_ck2     ........................................................................................................................
P21_kr_hc1     ........................................................................................................................
P22_kr_hb1     ........................................................................................................................
P23_kr_hb2     ........................................................................................................................
P24_kr_mh1     ........................................................................................................................
P24_kr_mh2     ........................................................................................................................
p25_kr_tb1     ........................................................................................................................
p25_kr_tb2     ........................................................................................................................
P26_kr_tb3     ........................................................................................................................
P27_kr_so1     ........................................................................................................................
P27_kr_so2     ........................................................................................................................
P27_kr_so3     ........................................................................................................................
P27_kr_so4     ........................................................................................................................
P27_kr_so5     ........................................................................................................................
P27_kr_so6     ........................................................................................................................
P28_kr_il1     ........................................................................................................................
P29_kr_mj1     ........................................................................................................................
P29_kr_mj2     ........................................................................................................................
P30_kr_dk1     ........................................................................................................................
P31_kr_jr1     ........................................................................................................................
O1_jp_rb1      ........................................................................................................................
O2_jp_hk1      .............................................................................T..........................................
O2_jp_hk2      ........................................................................................................................
O2_jp_hk3      ........................................................................................................................
O2_jp_hk4      ........................................................................................................................
J1_jp_hn1      ........................................................................................................................
J1_jp_hn2      ........................................................................................................................
J2_jp_ky1      ........................................................................................................................
J3_jp_jp1      ........................................................................................................................
B1_cn_bj1      ........................................................................................................................
B2_uk_1        .........A..............................................................................................................
AMP_cn_1       ...............................C...............................C.......................................C....T...........
SUF_kr_hl1     ...............................C...........C...................C...................................G...C....T...........
SUF_kr_hl2     ...............................C...........C...................C...................................G...C....T...........
```

Appendix 2. (Continued).

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                                                                                                                                   3480
A1_kr_gr1      AGACAATACTATGTTATTCCCGCTGCTTGTATTGATTTTATTTACTTTATTTATTGGAGTCATAGGAATTCCTTTCAACCAAGAAGGCATAGATTTGGATATATTGTCCAAATGGTTAAC
A1_kr_gr2      ........................................................................................................................
A2_kr_hl1      ........................................................................................................................
A2_kr_hl2      ........................................................................................................................
A2_kr_hl3      ........................................................................................................................
A2_kr_hl4      ........................................................................................................................
A3_kr_hl5      ........................................................................................................................
A3_kr_hl6      ........................................................................................................................
A3_kr_hl7      ........................................................................................................................
A3_kr_hl8      ........................................................................................................................
A4_kr_hl9      ........................................................................................................................
A5_kr_hl10     ........................................................................................................................
A5_kr_hl11     ........................................................................................................................
A5_kr_hl12     ........................................................................................................................
A5_kr_hl13     ........................................................................................................................
A5_kr_hl14     ........................................................................................................................
A7_mn_1        ........................................................................................................................
A8_mn_2        ........................................................................................................................
M1_rs_kb1      ........................................................................................................................
M2_rs_kh1      ........................................................................................................................
M2_rs_kh2      ........................................................................................................................
M2_rs_kh3      ........................................................................................................................
M3_rs_kh4      ........................................................................................................................
M3_rs_kh5      ........................................................................................................................
M3_rs_kh6      ........................................................................................................................
M3_rs_kh7      ........................................................................................................................
M3_rs_kh8      ........................................................................................................................
M3_rs_kh9      ........................................................................................................................
M3_rs_kh10     ........................................................................................................................
M3_rs_kh11     ........................................................................................................................
M3_rs_kh12     ........................................................................................................................
M3_rs_kh13     ........................................................................................................................
M3_rs_kh14     ........................................................................................................................
M3_rs_kh15     ........................................................................................................................
M3_rs_kh16     ........................................................................................................................
M3_rs_kh17     ........................................................................................................................
M3_rs_kh18     ........................................................................................................................
M3_rs_kh19     ........................................................................................................................
M3_rs_kh20     ........................................................................................................................
M3_rs_kh21     ........................................................................................................................
M3_rs_kh22     ........................................................................................................................
M3_rs_kh23     ........................................................................................................................
M3_rs_kh24     ........................................................................................................................
M3_rs_kh25     ........................................................................................................................
M3_rs_kh26     ........................................................................................................................
M3_rs_kh27     ........................................................................................................................
M3_rs_kh28     ........................................................................................................................
M3_rs_kh29     ........................................................................................................................
M3_rs_kh30     ........................................................................................................................
M3_rs_kh31     ........................................................................................................................
M4_rs_kh32     ........................................................................................................................
M5_rs_ot1      ........................................................................................................................
M6_rs_ri1      ........................................................................................................................
M6_rs_ri2      ........................................................................................................................
M7_cn_hj1      ........................................................................................................................
M8_cn_hj2      ........................................................................................................................
M8_cn_hj3      ........................................................................................................................
M8_cn_hj4      ........................................................................................................................
M9_cn_hj5      ........................................................................................................................
M10_cn_nm1     ........................................................................................................................
M11_cn_ul1     ........................................................................................................................
M12_cn_sb1     ........................................................................................................................
M12_cn_sb2     ........................................................................................................................
M13_kr_od1     ........................................................................................................................
M14_kr_jm1     ........................................................................................................................
M14_kr_jm2     ........................................................................................................................
M14_kr_jm3     ........................................................................................................................
M15_kr_dg1     ........................................................................................................................
M16_kr_dr1     ........................................................................................................................
M17_kr_sw1     ........................................................................................................................
M17_kr_sw2     ........................................................................................................................
M18_kr_hg1     ........................................................................................................................
M19_kr_gy1     ........................................................................................................................
M20_kr_nh1     ........................................................................................................................
M20_kr_nh2     ........................................................................................................................
M21_kr_gu1     ........................................................................................................................
M22_kr_mp1     ........................................................................................................................
M23_kr_bc1     ........................................................................................................................
M24_kr_os1     ........................................................................................................................
M25_kr_os2     ........................................................................................................................
M25_kr_os3     ........................................................................................................................
M25_kr_os4     ........................................................................................................................
M25_kr_os5     ........................................................................................................................
M26_kr_sn1     ........................................................................................................................
M27_kr_gn1     ........................................................................................................................
M27_kr_gn2     ........................................................................................................................
M28_kr_bs1     ........................................................................................................................
M28_kr_bs2     ........................................................................................................................
M28_kr_bs3     ........................................................................................................................
M29_kr_jn1     ........................................................................................................................
M30_kr_bl1     ........................................................................................................................
M30_kr_bl2     ........................................................................................................................
M31_kr_jl1     ............................A...........................................................................................
M31_kr_jl2     ........................................................................................................................
M32_kr_mt1     ........................................................................................................................
M33_kr_md1     ..........G.............................................................................................................
M33_kr_md2     ..........G.............................................................................................................
```

Appendix 2. (Continued).

```
                                                                                                                                   3480
A1_kr_gr1      AGACAATACTATGTTATTCCCGCTGCTTGTATTGATTTTATTTACTTTATTTATTGGAGTCATAGGAATTCCTTTCAACCAAGAAGGCATAGATTTGGATATATTGTCCAAATGGTTAAC
M34_kr_dn1     ........................................................................................................................
M34_kr_dn2     ........................................................................................................................
M35_kr_sm1     ........................................................................................................................
M35_kr_sm2     ........................................................................................................................
P1_rs_ms1      ........................................................................................................................
P1_rs_ms2      ........................................................................................................................
P1_rs_ms3      ........................................................................................................................
P1_rs_ms4      ........................................................................................................................
P2_rs_nk1      ........................................................................................................................
P2_rs_nk2      ........................................................................................................................
P3_rs_pr1      ........................................................................................................................
P4_rs_pr2      ........................................................................................................................
P4_rs_pr3      ........................................................................................................................
P5_rs_rc1      ........................................................................................................................
P5_rs_rc2      ........................................................................................................................
P5_rs_rc3      ........................................................................................................................
P6_rs_rc4      ........................................................................................................................
P6_rs_rc5      ........................................................................................................................
P6_rs_rc6      ........................................................................................................................
P6_rs_rc7      ........................................................................................................................
P6_rs_rc8      ........................................................................................................................
P7_rs_us1      ........................................................................................................................
P7_rs_us2      ........................................................................................................................
P8_rs_pr4      ........................................................................................................................
P9_rs_pr5      ........................................................................................................................
P10_cn_jl1     ........................................................................................................................
P10_cn_jl2     ........................................................................................................................
P11_cn_jl3     ........................................................................................................................
P11_cn_jl4     ........................................................................................................................
P12_cn_sn1     ........................................................................................................................
P12_cn_sn2     ........................................................................................................................
P13_cn_mc1     ........................................................................................................................
P13_cn_mc2     ........................................................................................................................
P14_kr_hw1     ........................................................................................................................
P14_kr_hw2     ........................................................................................................................
P15_kr_dm1     ........................................................................................................................
P15_kr_dm2     ........................................................................................................................
P15_kr_dm3     ........................................................................................................................
P16_kr_sk1     ........................................................................................................................
P16_kr_sk2     ........................................................................................................................
P16_kr_sk3     ........................................................................................................................
P16_kr_sk4     ........................................................................................................................
P16_kr_sk5     ........................................................................................................................
P16_kr_sk6     ........................................................................................................................
P16_kr_sk7     ........................................................................................................................
P16_kr_sk8     ........................................................................................................................
P17_kr_sh1     ........................................................................................................................
P18_kr_gb1     ........................................................................................................................
P19_kr_gw1     ........................................................................................................................
P19_kr_gw2     ........................................................................................................................
P19_kr_gw3     ........................................................................................................................
P20_kr_ck1     ........................................................................................................................
P20_kr_ck2     ........................................................................................................................
P21_kr_hc1     ........................................................................................................................
P22_kr_hb1     ........................................................................................................................
P23_kr_hb2     ........................................................................................................................
P24_kr_mh1     ........................................................................................................................
P24_kr_mh2     ........................................................................................................................
p25_kr_tb1     ........................................................................................................................
p25_kr_tb2     ........................................................................................................................
P26_kr_tb3     ........................................................................................................................
P27_kr_so1     ........................................................................................................................
P27_kr_so2     ........................................................................................................................
P27_kr_so3     ........................................................................................................................
P27_kr_so4     ........................................................................................................................
P27_kr_so5     ........................................................................................................................
P27_kr_so6     ........................................................................................................................
P28_kr_il1     ........................................................................................................................
P29_kr_mj1     ........................................................................................................................
P29_kr_mj2     ........................................................................................................................
P30_kr_dk1     ........................................................................................................................
P31_kr_jr1     ........................................................................................................................
O1_jp_rb1      .......................................................................................................................
O2_jp_hk1      ........................................................................................................................
O2_jp_hk2      ........................................................................................................................
O2_jp_hk3      ........................................................................................................................
O2_jp_hk4      ........................................................................................................................
J1_jp_hn1      ........................................................................................................................
J1_jp_hn2      ........................................................................................................................
J2_jp_ky1      ........................................................................................................................
J3_jp_jp1      ........................................................................................................................
B1_cn_bj1      ........................................................................................................................
B2_uk_1        ........................................................................................................................
AMP_cn_1       ...................................................C....................................................................
SUF_kr_hl1     ...................................................C.....C..............................................................
SUF_kr_hl2     ...................................................C.....C..............................................................
```

Appendix 2. (Continued).

```
                                                                                                                                   3600
A1_kr_gr1      CCCATCTATAAACCTTTTGCATCCAAAATGGAATAATCCAAAGAATTTTGATTGGGCGGAATTTGTAACAAATGCAACCTTTTCGGTTAGTATAGCTTATTCGGGAATAGTTATAGCGTT
A1_kr_gr2      ........................................................................................................................
A2_kr_hl1      ........................................................................................................................
A2_kr_hl2      ........................................................................................................................
A2_kr_hl3      ........................................................................................................................
A2_kr_hl4      ........................................................................................................................
A3_kr_hl5      ........................................................................................................................
A3_kr_hl6      ........................................................................................................................
A3_kr_hl7      ........................................................................................................................
A3_kr_hl8      ........................................................................................................................
A4_kr_hl9      ........................................................................................................................
A5_kr_hl10     ........................................................................................................................
A5_kr_hl11     ........................................................................................................................
A5_kr_hl12     ........................................................................................................................
A5_kr_hl13     ........................................................................................................................
A5_kr_hl14     ........................................................................................................................
A7_mn_1        ........................................................................................................................
A8_mn_2        ........................................................................................................................
M1_rs_kb1      ........................................................................................................................
M2_rs_kh1      ........................................................................C...............................................
M2_rs_kh2      ........................................................................C...............................................
M2_rs_kh3      ........................................................................C...............................................
M3_rs_kh4      ........................................................................C...............................................
M3_rs_kh5      ........................................................................C...............................................
M3_rs_kh6      ........................................................................................................................
M3_rs_kh7      ........................................................................................................................
M3_rs_kh8      ........................................................................C...............................................
M3_rs_kh9      ........................................................................................................................
M3_rs_kh10     ........................................................................................................................
M3_rs_kh11     ........................................................................................................................
M3_rs_kh12     ........................................................................................................................
M3_rs_kh13     ........................................................................................................................
M3_rs_kh14     ........................................................................................................................
M3_rs_kh15     ........................................................................C...............................................
M3_rs_kh16     ........................................................................C...............................................
M3_rs_kh17     ........................................................................C...............................................
M3_rs_kh18     ........................................................................................................................
M3_rs_kh19     ........................................................................C...............................................
M3_rs_kh20     ........................................................................................................................
M3_rs_kh21     ........................................................................C...............................................
M3_rs_kh22     ........................................................................C...............................................
M3_rs_kh23     ........................................................................................................................
M3_rs_kh24     ........................................................................C...............................................
M3_rs_kh25     ........................................................................C...............................................
M3_rs_kh26     ........................................................................................................................
M3_rs_kh27     ........................................................................C...............................................
M3_rs_kh28     ........................................................................C...............................................
M3_rs_kh29     ........................................................................C...............................................
M3_rs_kh30     ........................................................................................................................
M3_rs_kh31     ........................................................................C...............................................
M4_rs_kh32     ........................................................................C...............................................
M5_rs_ot1      ...........C.................T..........................................................................................
M6_rs_ri1      .............................T..........................................................................................
M6_rs_ri2      ........................................................................................................................
M7_cn_hj1      ........................................................................................................................
M8_cn_hj2      ........................................................................................................................
M8_cn_hj3      ........................................................................................................................
M8_cn_hj4      ........................................................................................................................
M9_cn_hj5      ........................................................................................................................
M10_cn_nm1     ........................................................................................................................
M11_cn_ul1     ........................................................................................................................
M12_cn_sb1     ........................................................................................................................
M12_cn_sb2     ........................................................................................................................
M13_kr_od1     ........................................................................................................................
M14_kr_jm1     .............................T..........................................................................................
M14_kr_jm2     .............................T..........................................................................................
M14_kr_jm3     .............................T..........................................................................................
M15_kr_dg1     ........................................................................................................................
M16_kr_dr1     ........................................................................................................................
M17_kr_sw1     ........................................................................................................................
M17_kr_sw2     ........................................................................................................................
M18_kr_hg1     ........................................................................................................................
M19_kr_gy1     ........................................................................................................................
M20_kr_nh1     .............................T..........................................................................................
M20_kr_nh2     .............................T..........................................................................................
M21_kr_gu1     ........................................................................................................................
M22_kr_mp1     ........................................................................................................................
M23_kr_bc1     ........................................................................................................................
M24_kr_os1     ........................................................................................................................
M25_kr_os2     ........................................................................................................................
M25_kr_os3     .............................T..........................................................................................
M25_kr_os4     ........................................................................................................................
M25_kr_os5     ........................................................................................................................
M26_kr_sn1     ........................................................................................................................
M27_kr_gn1     ........................................................................................................................
M27_kr_gn2     ........................................................................................................................
M28_kr_bs1     .............................T..........................................................................................
M28_kr_bs2     ........................................................................................................................
M28_kr_bs3     .............................T..........................................................................................
M29_kr_jn1     ........................................................................................................................
M30_kr_bl1     ........................................................................................................................
M30_kr_bl2     .............................T..........................................................................................
M31_kr_jl1     .............................T..........................................................................................
M31_kr_jl2     ........................................................................................................................
M32_kr_mt1     ........................................................................................................................
M33_kr_md1     ........................................................................................................................
M33_kr_md2     ........................................................................................................................
```

Appendix 2. (Continued).

```
                                                                                                                                   3600
A1_kr_gr1      CCCATCTATAAACCTTTTGCATCCAAAATGGAATAATCCAAAGAATTTTGATTGGGCGGAATTTGTAACAAATGCAACCTTTTCGGTTAGTATAGCTTATTCGGGAATAGTTATAGCGTT
M34_kr_dn1     ........................................................................................................................
M34_kr_dn2     ........................................................................................................................
M35_kr_sm1     ........................................................................................................................
M35_kr_sm2     ........................................................................................................................
P1_rs_ms1      ........................................................................................................................
P1_rs_ms2      ........................................................................................................................
P1_rs_ms3      ........................................................................................................................
P1_rs_ms4      ........................................................................................................................
P2_rs_nk1      ........................................................................................................................
P2_rs_nk2      ........................................................................................................................
P3_rs_pr1      ........................................................................................................................
P4_rs_pr2      ........................................................................................................................
P4_rs_pr3      .............................T..........................................................................................
P5_rs_rc1      ...........C.................T..........................................................................................
P5_rs_rc2      ........................................................................................................................
P5_rs_rc3      ........................................................................................................................
P6_rs_rc4      .............................T..........................................................................................
P6_rs_rc5      .............................T..........................................................................................
P6_rs_rc6      .............................T..........................................................................................
P6_rs_rc7      .............................T..........................................................................................
P6_rs_rc8      ........................................................................................................................
P7_rs_us1      ........................................................................................................................
P7_rs_us2      ........................................................................................................................
P8_rs_pr4      ........................................................................................................................
P9_rs_pr5      ...........C.................T..........................................................................................
P10_cn_jl1     ........................................................................................................................
P10_cn_jl2     ........................................................................................................................
P11_cn_jl3     .............................T..........................................................................................
P11_cn_jl4     ........................................................................................................................
P12_cn_sn1     .......................................................................................................................
P12_cn_sn2     ........................................................................................................................
P13_cn_mc1     ........................................................................................................................
P13_cn_mc2     ........................................................................................................................
P14_kr_hw1     ........................................................................................................................
P14_kr_hw2     ........................................................................................................................
P15_kr_dm1     ........................................................................................................................
P15_kr_dm2     ........................................................................................................................
P15_kr_dm3     ........................................................................................................................
P16_kr_sk1     .....................................................................................................................A..
P16_kr_sk2     .....................................................................................................................A..
P16_kr_sk3     .....................................................................................................................A..
P16_kr_sk4     .....................................................................................................................A..
P16_kr_sk5     ........................................................................................................................
P16_kr_sk6     .....................................................................................................................A..
P16_kr_sk7     .....................................................................................................................A..
P16_kr_sk8     .....................................................................................................................A..
P17_kr_sh1     ........................................................................................................................
P18_kr_gb1     ........................................................................................................................
P19_kr_gw1     ........................................................................................................................
P19_kr_gw2     ........................................................................................................................
P19_kr_gw3     ........................................................................................................................
P21_kr_hc1     ........................................................................................................................
P20_kr_ck1     ........................................................................................................................
P20_kr_ck2     ........................................................................................................................
P22_kr_hb1     ........................................................................................................................
P23_kr_hb2     .........................................................................................................................
P24_kr_mh1     ........................................................................................................................
P24_kr_mh2     ........................................................................................................................
p25_kr_tb1     ........................................................................................................................
p25_kr_tb2     ........................................................................................................................
P26_kr_tb3     ........................................................................................................................
P27_kr_so1     ........................................................................................................................
P27_kr_so2     ........................................................................................................................
P27_kr_so3     ........................................................................................................................
P27_kr_so4     ........................................................................................................................
P27_kr_so5     ........................................................................................................................
P27_kr_so6     ........................................................................................................................
P28_kr_il1     ........................................................................................................................
P29_kr_mj1     ........................................................................................................................
P29_kr_mj2     ........................................................................................................................
P30_kr_dk1     ........................................................................................................................
P31_kr_jr1     ........................................................................................................................
O1_jp_rb1      .......................................................................................................................
O2_jp_hk1      ........................................................................C...............................................
O2_jp_hk2      ........................................................................................................................
O2_jp_hk3      ........................................................................................................................
O2_jp_hk4      ........................................................................................................................
J1_jp_hn1      ........................................................................................................................
J1_jp_hn2      ........................................................................................................................
J2_jp_ky1      .............................T..........................................................................................
J3_jp_jp1      ........................................................................................................................
B1_cn_bj1      .............................T..........................................................................................
B2_uk_1        .............................T..........................................................................................
AMP_cn_1       .............................TT......A.................................................................................C
SUF_kr_hl1     .............................T.........................................................................................C
SUF_kr_hl2     .............................T.........................................................................................C
```

Appendix 2. (Continued).

```
                                                                                                                                   3720
A1_kr_gr1      TTTTTTATATAAACCCGTTTATTCATCCTTACAAAATTTTGTCTTAATTAATTATTTTGCCAAAAGGCACCCAAATCGGGGTTTTTCAGACAAAATAAAAAATTTAATATATGATTGGGC
A1_kr_gr2      ........................................................................................................................
A2_kr_hl1      ........................................................................................................................
A2_kr_hl2      ........................................................................................................................
A2_kr_hl3      ........................................................................................................................
A2_kr_hl4      ........................................................................................................................
A3_kr_hl5      ........................................................................................................................
A3_kr_hl6      ........................................................................................................................
A3_kr_hl7      ........................................................................................................................
A3_kr_hl8      ........................................................................................................................
A4_kr_hl9      ........................................................................................................................
A5_kr_hl10     ........................................................................................................................
A5_kr_hl11     ........................................................................................................................
A5_kr_hl12     ........................................................................................................................
A5_kr_hl13     ........................................................................................................................
A5_kr_hl14     ........................................................................................................................
A7_mn_1        ........................................................................................................................
A8_mn_2        ........................................................................................................................
M1_rs_kb1      ........................................................................................................................
M2_rs_kh1      ........................................................................................................................
M2_rs_kh2      ........................................................................................................................
M2_rs_kh3      ........................................................................................................................
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M3_rs_kh5      ........................................................................................................................
M3_rs_kh6      ........................................................................................................................
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M3_rs_kh31     ........................................................................................................................
M4_rs_kh32     ........................................................................................................................
M5_rs_ot1      ........................................................................................................................
M6_rs_ri1      .......................................................................A................................................
M6_rs_ri2      ........................................................................................................................
M7_cn_hj1      ......T.................................................................................................................
M8_cn_hj2      ........................................................................................................................
M8_cn_hj3      ........................................................................................................................
M8_cn_hj4      ........................................................................................................................
M9_cn_hj5      ........................................................................................................................
M10_cn_nm1     .................................................................................................C......................
M11_cn_ul1     ........................................................................................................................
M12_cn_sb1     ........................................................................................................................
M12_cn_sb2     ........................................................................................................................
M13_kr_od1     ........................................................................................................................
M14_kr_jm1     ........................................................................................................................
M14_kr_jm2     ........................................................................................................................
M14_kr_jm3     ........................................................................................................................
M15_kr_dg1     ......T.................................................................................................................
M16_kr_dr1     ........................................................................................................................
M17_kr_sw1     ........................................................................................................................
M17_kr_sw2     ........................................................................................................................
M18_kr_hg1     ........................................................................................................................
M19_kr_gy1     ........................................................................................................................
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M20_kr_nh2     ........................................................................................................................
M21_kr_gu1     ........................................................................................................................
M22_kr_mp1     ........................................................................................................................
M23_kr_bc1     ........................................................................................................................
M24_kr_os1     ........................................................................................................................
M25_kr_os2     ........................................................................................................................
M25_kr_os3     .......................................................................A................................................
M25_kr_os4     ........................................................................................................................
M25_kr_os5     ........................................................................................................................
M26_kr_sn1     ........................................................................................................................
M27_kr_gn1     ........................................................................................................................
M27_kr_gn2     ........................................................................................................................
M28_kr_bs1     ...............................................................C........................................................
M28_kr_bs2     ........................................................................................................................
M28_kr_bs3     ...............................................................C........................................................
M29_kr_jn1     .......................................................................................................................
M30_kr_bl1     ........................................................................................................................
M30_kr_bl2     ........................................................................................................................
M31_kr_jl1     ........................................................................................................................
M31_kr_jl2     ........................................................................................................................
M32_kr_mt1     ........................................................................................................................
M33_kr_md1     ........................................................................................................................
M33_kr_md2     ........................................................................................................................
```

Appendix 2. (Continued).

```
                                                                                                                                   3720
A1_kr_gr1      TTTTTTATATAAACCCGTTTATTCATCCTTACAAAATTTTGTCTTAATTAATTATTTTGCCAAAAGGCACCCAAATCGGGGTTTTTCAGACAAAATAAAAAATTTAATATATGATTGGGC
M34_kr_dn1     ........................................................................................................................
M34_kr_dn2     ........................................................................................................................
M35_kr_sm1     ........................................................................................................................
M35_kr_sm2     ........................................................................................................................
P1_rs_ms1      ........................................................................................................................
P1_rs_ms2      ........................................................................................................................
P1_rs_ms3      ........................................................................................................................
P1_rs_ms4      ........................................................................................................................
P2_rs_nk1      ........................................................................................................................
P2_rs_nk2      ........................................................................................................................
P3_rs_pr1      ........................................................................................................................
P4_rs_pr2      ........................................................................................................................
P4_rs_pr3      .......................................................................A................................................
P5_rs_rc1      ........................................................................................................................
P5_rs_rc2      ........................................................................................................................
P5_rs_rc3      ........................................................................................................................
P6_rs_rc4      ...............................................................C........................................................
P6_rs_rc5      ...............................................................C........................................................
P6_rs_rc6      ...............................................................C........................................................
P6_rs_rc7      ...............................................................C........................................................
P6_rs_rc8      ........................................................................................................................
P7_rs_us1      ........................................................................................................................
P7_rs_us2      ........................................................................................................................
P8_rs_pr4      ........................................................................................................................
P9_rs_pr5      ........................................................................................................................
P10_cn_jl1     ........................................................................................................................
P10_cn_jl2     ........................................................................................................................
P11_cn_jl3     ...............................................................C........................................................
P11_cn_jl4     ........................................................................................................................
P12_cn_sn1     ........................................................................................................................
P12_cn_sn2     ........................................................................................................................
P13_cn_mc1     ........................................................................................................................
P13_cn_mc2     ........................................................................................................................
P14_kr_hw1     ........................................................................................................................
P14_kr_hw2     ........................................................................................................................
P15_kr_dm1     ........................................................................................................................
P15_kr_dm2     ........................................................................................................................
P15_kr_dm3     ........................................................................................................................
P16_kr_sk1     ........................................................................................................................
P16_kr_sk2     ........................................................................................................................
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P16_kr_sk6     ........................................................................................................................
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P16_kr_sk8     ........................................................................................................................
P17_kr_sh1     ........................................................................................................................
P18_kr_gb1     ........................................................................................................................
P19_kr_gw1     ........................................................................................................................
P19_kr_gw2     ........................................................................................................................
P19_kr_gw3     ........................................................................................................................
P20_kr_ck1     ........................................................................................................................
P20_kr_ck2     ........................................................................................................................
P21_kr_hc1     ........................................................................................................................
P22_kr_hb1     ........................................................................................................................
P23_kr_hb2     ........................................................................................................................
P24_kr_mh1     ........................................................................................................................
P24_kr_mh2     ........................................................................................................................
p25_kr_tb1     ........................................................................................................................
p25_kr_tb2     ........................................................................................................................
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P27_kr_so2     ........................................................................................................................
P27_kr_so3     ........................................................................................................................
P27_kr_so4     ........................................................................................................................
P27_kr_so5     ........................................................................................................................
P27_kr_so6     ........................................................................................................................
P28_kr_il1     ........................................................................................................................
P29_kr_mj1     ........................................................................................................................
P29_kr_mj2     ........................................................................................................................
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P31_kr_jr1     ........................................................................................................................
O1_jp_rb1      ........................................................................................................................
O2_jp_hk1      ........................................................................................................................
O2_jp_hk2      ........................................................................................................................
O2_jp_hk3      ........................................................................................................................
O2_jp_hk4      ........................................................................................................................
J1_jp_hn1      ........................................................................................................................
J1_jp_hn2      ........................................................................................................................
J2_jp_ky1      ........................................................................................................................
J3_jp_jp1      ........................................................................................................................
B1_cn_bj1      ........................................................................................................................
B2_uk_1        ........................................................................................................................
AMP_cn_1       .........................................C..................................A...........................................
SUF_kr_hl1     .........................................C..................................A...........................................
SUF_kr_hl2     .........................................C..................................A...........................................
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Appendix 2. (Continued).

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                                                                                              3803
A1_kr_gr1      CCATCATCGTGGTTACATAGATGCTTTTTATACAACATATGTAATTCGGAGTGTAAGAGGATTGTCCGAACTAGTTCATTTTT      [3801]
A1_kr_gr2      ...................................................................................      [3801]
A2_kr_hl1      .......A...........................................................................      [3801]
A2_kr_hl2      ...................................................................................      [3801]
A2_kr_hl3      ...............................................................A...................      [3801]
A2_kr_hl4      ......................................G............................................      [3801]
A3_kr_hl5      ...................................................................................      [3801]
A3_kr_hl6      ...............................................................A...................      [3801]
A3_kr_hl7      ......................................G............................................      [3801]
A3_kr_hl8      ......................................G............................................      [3801]
A4_kr_hl9      ...................................................................................      [3801]
A5_kr_hl10     ...................................................................................      [3801]
A5_kr_hl11     ...............................................................A...................      [3801]
A5_kr_hl12     ...................................................................................      [3801]
A5_kr_hl13     ...............................................................A...................      [3801]
A5_kr_hl14     ...................................................................................      [3801]
A7_mn_1        ...................................................................................      [3801]
A8_mn_2        ...................................................................................      [3801]
M1_rs_kb1      ...................................................................................      [3801]
M2_rs_kh1      ...................................................................................      [3801]
M2_rs_kh2      ...................................................................................      [3801]
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M3_rs_kh6      ...................................................................................      [3801]
M3_rs_kh7      ...................................................................................      [3801]
M3_rs_kh8      ...................................................................................      [3801]
M3_rs_kh9      ...................................................................................      [3801]
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M3_rs_kh31     ...................................................................................      [3801]
M4_rs_kh32     ...................................................................................      [3801]
M5_rs_ot1      ...................................................................................      [3801]
M6_rs_ri1      ...................................................................................      [3801]
M6_rs_ri2      ...................................................................................      [3801]
M7_cn_hj1      ...................................................................................      [3801]
M8_cn_hj2      ...................................................................................      [3801]
M8_cn_hj3      ...................................................................................      [3801]
M8_cn_hj4      ...................................................................................      [3801]
M9_cn_hj5      ...................................................................................      [3801]
M10_cn_nm1     ...................................................................................      [3801]
M11_cn_ul1     ...................................................................................      [3801]
M12_cn_sb1     ...................................................................................      [3801]
M12_cn_sb2     ...................................................................................      [3801]
M13_kr_od1     ...................................................................................      [3801]
M14_kr_jm1     ...................................................................................      [3801]
M14_kr_jm2     ...................................................................................      [3801]
M14_kr_jm3     ...................................................................................      [3801]
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M19_kr_gy1     ...................................................................................      [3801]
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M20_kr_nh2     ...................................................................................      [3801]
M21_kr_gu1     ...................................................................................      [3801]
M22_kr_mp1     ...................................................................................      [3801]
M23_kr_bc1     ...................................................................................      [3801]
M24_kr_os1     ...................................................................................      [3801]
M25_kr_os2     ...................................................................................      [3801]
M25_kr_os3     ...................................................................................      [3801]
M25_kr_os4     ...................................................................................      [3801]
M25_kr_os5     ...................................................................................      [3802]
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M27_kr_gn1     ...................................................................................      [3801]
M27_kr_gn2     ...................................................................................      [3801]
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M28_kr_bs2     ...................................................................................      [3801]
M28_kr_bs3     ...................................................................................      [3801]
M29_kr_jn1     ...................................................................................      [3801]
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M30_kr_bl2     ...................................................................................      [3801]
M31_kr_jl1     ...................................................................................      [3801]
M31_kr_jl2     ...................................................................................      [3801]
M32_kr_mt1     ...................................................................................      [3801]
M33_kr_md1     ...................................................................................      [3801]
M33_kr_md2     ...................................................................................      [3801]
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Appendix 2. (Continued).

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                                                                                              3803
A1_kr_gr1      CCATCATCGTGGTTACATAGATGCTTTTTATACAACATATGTAATTCGGAGTGTAAGAGGATTGTCCGAACTAGTTCATTTTT      [3801]
M34_kr_dn1     ...................................................................................      [3801]
M34_kr_dn2     ...................................................................................      [3801]
M35_kr_sm1     ...................................................................................      [3801]
M35_kr_sm2     ...................................................................................      [3801]
P1_rs_ms1      ...................................................................................      [3801]
P1_rs_ms2      ...................................................................................      [3801]
P1_rs_ms3      ...................................................................................      [3801]
P1_rs_ms4      ...................................................................................      [3801]
P2_rs_nk1      ...................................................................................      [3801]
P2_rs_nk2      ...................................................................................      [3801]
P3_rs_pr1      ...................................................................................      [3801]
P4_rs_pr2      ...................................................................................      [3801]
P4_rs_pr3      ...................................................................................      [3801]
P5_rs_rc1      ...................................................................................      [3801]
P5_rs_rc2      ...................................................................................      [3801]
P5_rs_rc3      ...................................................................................      [3801]
P6_rs_rc4      ...................................................................................      [3801]
P6_rs_rc5      ...................................................................................      [3801]
P6_rs_rc6      ...................................................................................      [3801]
P6_rs_rc7      ...................................................................................      [3801]
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P7_rs_us1      ...................................................................................      [3801]
P7_rs_us2      ...................................................................................      [3801]
P8_rs_pr4      ...................................................................................      [3801]
P9_rs_pr5      ...................................................................................      [3801]
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P13_cn_mc2     ...................................................................................      [3801]
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P14_kr_hw2     ...................................................................................      [3801]
P15_kr_dm1     .......A...........................................................................      [3801]
P15_kr_dm2     .......A...........................................................................      [3801]
P15_kr_dm3     .......A...........................................................................      [3801]
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P16_kr_sk5     ...................................................................................      [3801]
P16_kr_sk6     ...................................................................................      [3801]
P16_kr_sk7     ...................................................................................      [3801]
P16_kr_sk8     ...................................................................................      [3801]
P17_kr_sh1     .......A...........................................................................      [3801]
P18_kr_gb1     ...................................................................................      [3801]
P19_kr_gw1     ...................................................................................      [3801]
P19_kr_gw2     ...................................................................................      [3801]
P19_kr_gw3     ...................................................................................      [3801]
P20_kr_ck1     ...................................................................................      [3801]
P20_kr_ck2     ...................................................................................      [3801]
P21_kr_hc1     ...................................................................................      [3801]
P22_kr_hb1     ...................................................................................      [3801]
P23_kr_hb2     ...................................................................................      [3801]
P24_kr_mh1     ...................................................................................      [3801]
P24_kr_mh2     ...................................................................................      [3801]
p25_kr_tb1     ...................................................................................      [3801]
p25_kr_tb2     ...................................................................................      [3801]
P26_kr_tb3     ...................................................................................      [3801]
P27_kr_so1     ...................................................................................      [3801]
P27_kr_so2     ...................................................................................      [3801]
P27_kr_so3     ...................................................................................      [3801]
P27_kr_so4     ...................................................................................      [3801]
P27_kr_so5     ...................................................................................      [3801]
P27_kr_so6     ...................................................................................      [3801]
P28_kr_il1     ...................................................................................      [3801]
P29_kr_mj1     ...................................................................................      [3801]
P29_kr_mj2     ...................................................................................      [3801]
P30_kr_dk1     ...................................................................................      [3801]
P31_kr_jr1     ...................................................................................      [3801]
O1_jp_rb1      ...................................................................................      [3801]
O2_jp_hk1      ...................................................................................      [3801]
O2_jp_hk2      ...................................................................................      [3801]
O2_jp_hk3      ...................................................................................      [3801]
O2_jp_hk4      ...................................................................................      [3801]
J1_jp_hn1      ...................................................................................      [3801]
J1_jp_hn2      ...................................................................................      [3801]
J2_jp_ky1      ...................................................................................      [3801]
J3_jp_jp1      ...................................................................................      [3801]
B1_cn_bj1      ...................................................................................      [3801]
B2_uk_1        ...................................................................................      [3801]
AMP_cn_1       .......................T...........................................................      [3796]
SUF_kr_hl1     ..................C................................................................      [3802]
SUF_kr_hl2     ..................C................................................................      [3802]
```

국문초록

Bistorta manshuriensis complex는 동북아 지역 (한반도, 중국 동북부, 러시아 극동 및 일본)에 분포하는 형태학적으로 매우 유연관계가 깊은 또는 변이가 복잡한 5개 분류군을 포함한다. 본 complex 내에는 계통분류학적으로 많은 문제점이 누적되어 있다. 본 *B. manshuriensis* complex 분류군의 한계 및 실체와 종간 유연관계를 규명하기 위해 주요 형태형질 연구 및 DNA 염기서열을 분석하였다. 주성분 분석을 포함한 비교 형태분석 결과, 본 complex에 속하는 분류군들은 잎의 형태, 길이, 최대폭, 엽병 날개 길이 등에 의해 서로 약하게 구분되는 것으로 나타났다. 조사된 *B. manshuriensis* complex 분류군에서 체세포 염색체 수는 2배체($2n$ = 24)와 4배체($2n$ = 48)로 확인되었다. 본 연구에서 조사된 *B. manshuriensis* complex 분류군 중에서 *B. manshuriensis*와 *B. alopecuroides*의 염색체 수는 처음으로 조사되었다. 본 complex 분류군들의 핵 ITS 및 엽록체 DNA 6개 구간 염기서열 분석을 위해 동북아 지역에 걸쳐 채집된 *B. manshuriensis* complex 분류군들의 82개체군 182개체를 이용하였다. 핵 ITS염기서열의 22개 substitution과 1개 indel을 근거로, 본 complex 내에는 28개의 ribotype이 존재하는 것으로 밝혀졌다. 본 complex의 경우, 분류군 및 지역집단 수준에서 핵 DNA ribotype polymorphism이 높은 것으로 나타났다. 한편, 28개 ribotype 중에는, 일부 분류군간에 공통적으로 분포하는 ITS ribotype이 존재하는 것으로 밝혀졌다. 엽록체 DNA 염기서열에 나타나는 64개의 substitution과 1개의 indel에 근거하여 본 complex 내에서 43개의 haplotype이 존재하는 것으로 밝혀졌다. 본 complex의 일부 분류군 간에는 공통적으로 분포하는 최소한 8개의 엽록체 DNA haplotype이

발견된다. TCS haplotype network와 계통수를 근거하여 본 complex에서 많은 lineage가 존재하는 것이 밝혀졌다. 그러나, lineage가 현재 인식되어 있는 분류군에 대해서 관계가 일치하지 않았다. 이러한 결과로 볼 때, 본 complex 분류군들은 하나의 공통조상에서 기원하였으나, 조상 분류군에 존재하던 유전적 다형성이 불완전 계통 분립(incomplete lineage sorting)에 의해 전이되면서 현재와 같은 복잡한 양상으로 분화된 것으로 추정된다. 본 연구에서는 상기한 결과들을 종합하여 *B. manshuriensis* complex를 3종 2아종으로 정리하고, 검색표 및 기재를 작성하여 분류학적 처리를 수행하였다.

Keywords: *Bistorta manshuriensis*, cpDNA, haplotype, ITS, 동북아 지역

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